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Report to
Parliament
on the
Administration
and Enforcement
of the



Energy Efficiency Act

1992 - 93

Canada

Report to
Parliament
on the
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and Enforcement
of the

Energy Efficiency Act

1992 - 93

His Excellency the Right Honourable Ramon Hnatyshyn,
P.C., C.C., C.M.M., C.D., Q.C.
Governor General and
Commander-in-Chief of Canada

Your Excellency:

I have the honour to present the *Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act* for the fiscal year ending March 31, 1993, in accordance with the provisions of section 36 of the said act.

Respectfully submitted,

A handwritten signature in dark ink, reading "A. Anne McLellan". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

A. Anne McLellan
Minister of Natural Resources

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Loi sur l'efficacité énergétique, 1992-1993*

Minister's Foreword



Canadians are experiencing a major transformation of their economy. This has created opportunities for some and upheaval for others. One theme of the emerging economy is sustainable development, which requires an integration of economic and environmental objectives.

This document reports on my department's activities in 1992-93 to promote energy efficiency and alternative energy (EAE), carried out under the auspices of the *Energy Efficiency Act*. These activities are an excellent example of the integration of economic and environmental objectives. Through these activities, energy users can reduce their energy bills and increase their wealth and economic competitiveness. At the same time, they will reduce the environmental impacts associated with energy use, including emissions that contribute to acid rain, urban smog and global climate change.

The Department of Natural Resources,¹ as did its predecessor, the Department of Energy, Mines and Resources, has long played a role in encouraging Canadians to make more efficient use of energy and greater use of alternative sources of energy. This includes a long and productive history of support for research and development offered by CANMET (the Canada Centre for Mineral and Energy Technology). The department's EAE marketing activities have evolved since their inception in the 1970s, when the focus was on reducing the use of oil in Canada, and these activities now emphasize the environmental benefits of achieving a higher level of energy efficiency and use of alternative energy sources. Many of these benefits were noted in the Green Plan (December 1990), which outlined an expanded EAE Program.

The department's EAE activities are aimed at overcoming the obstacles of inadequate consumer information and knowledge, and of institutional and financial constraints. The EAE Program employs suasion, regulation, cost-shared research and development, and information. It seeks to engage all sectors of the economy and society, and addresses all fuel types in its promotion of EAE investment opportunities. In 1992-93, some of the many notable achievements included:

- The opening of the Energy Diversification Research Laboratory in Varennes, Quebec. The new laboratory will advance work on improving the performance and cost-effectiveness of heat management, renewable energy and hybrid systems, and natural gas technologies.
- The *Energy Efficiency Act* received Royal Assent in June 1992 and came fully into force on January 1, 1993.
- The first showcase Advanced Houses, which use only 25 per cent of the energy consumed in a conventionally built home, were officially opened. These state-of-the-art houses have received a high level of interest by the public and have been recognized internationally for their leadership in the housing field.

¹ Under the Federal Identity Program, "Natural Resources Canada", abbreviated as NRCan, has been approved as the applied title of the Department of Energy, Mines and Resources.

- The Energy Innovators Venture recruited dozens of organizations and businesses to its program of voluntary energy-efficiency commitments, pilot projects and project replication.
- The Federal Buildings Initiative cleared away the obstacles to achieving greater energy efficiency in federal buildings and created a number of tools to help departments pursue opportunities for cost-effective reductions in their energy bills.

Work has continued since March 1993, of course, and will be duly described in the next *Energy Efficiency Act* annual report, covering fiscal year 1993-94. However, I am pleased to note here that:

- the discussions with several provinces on letters of cooperation on EAE program activity have resulted in several bilateral agreements;
- the first set of minimum energy-efficiency performance standards and energy labelling regulations under the *Energy Efficiency Act* should be pre-published early in 1994;
- the introduction of model National Energy Codes, containing both prescriptive and performance compliance paths for new buildings and houses, remains on schedule for 1994; and
- the Minister's Advisory Council on Industrial Energy Efficiency will be examining energy-efficiency policy, planning and project implementation within the industrial sector.

As well, we will be examining the possibilities for introducing new activities, particularly in the areas of energy use not covered by our current EAE Program. In this regard, I expect to launch:

- a residential buildings retrofit program, in cooperation with Canada Mortgage and Housing Corporation, Human Resources Development Canada and the buildings retrofit industry; and
- a Fleet Management Program for urban light-duty cars and trucks in Canada.

Our planning activities will include cooperation with other stakeholders in exploring the opportunities for meeting Canada's greenhouse gas limitation goals.

Along with their purpose and activities, the following report briefly describes the principal achievements recorded in 1992-93 by almost three dozen EAE initiatives. Some of them are well known to Canadians, but most have received little attention outside their targeted area of the economy. Therefore, I am pleased to provide Canadians, through this report, with the first complete listing in many years of this department's EAE activities. The document also outlines the environmental and economic benefits available to energy users through improving their energy efficiency and taking advantage of modern alternative energy technologies. I encourage Canadians to obtain information about these opportunities from my department, provincial energy departments, their energy suppliers or retailers of energy-using equipment. The information is there for the asking; the savings are there for the taking.

I look forward to reporting further on our progress, during my tenure as Minister of Natural Resources, in promoting greater energy efficiency and use of alternative energy sources as one aspect of responsible energy management in Canada.

A. Anne McLellan
Minister of Natural Resources



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Background and Policy Context

Overview

Natural Resources Canada (NRCan) supports energy efficiency and alternative energy to meet energy, environmental and economic objectives.

To put the department's efforts in context, chapter one describes:

- the importance of energy to Canadians;
- the relationship between energy use and atmospheric emissions; and

- the federal approach to energy efficiency and alternative energy.

Chapter two looks at NRCan's strategy to encourage Canadians to take advantage of opportunities to invest in greater energy efficiency and alternative energy. Chapters three through eight describe NRCan's energy efficiency and alternative energy programs.

The Energy Efficiency Act

On June 23, 1992, Royal Assent was given to the federal government's *Energy Efficiency Act* (the act). The act provides for the making and enforcement of regulations concerning energy efficiency and alternative energy (EAE), primarily:

- minimum energy-efficiency performance standards for energy-using products, doors and windows;
- the labelling of energy-using products, doors and windows to convey information on their energy efficiency; and
- the collection of statistics and information on energy use and alternative energy.

The act also provides the Minister with the authority to promote EAE. This is contained in section 21, which came into force on September 1, 1992. The rest of the statute came into force on January 1, 1993.

Section 36 states that after each fiscal year the Minister must table a report before Parliament on that fiscal year's administration and enforcement of the act. This document is the first annual report submitted under this legislation. Since the regulatory programs provided for in the act were not in place by the end of March 1993, this document reports on what was done to prepare for the new regulations and on activities undertaken to promote EAE. The reporting period begins September 1, 1992, the date section 21 came into force, and ends on March 31, 1993. However, most of the accompanying statistics are annual figures that convey a more informative picture of energy use in Canada.

Energy Use in Canada

■ *Energy and the Economy*

Canada has been and remains fortunate to have access to an abundance of energy and to different sources of energy. The reliable availability of energy at reasonable cost has been a key factor in the attainment of a high standard of living. This advantage led to the development of industries with a particularly strong demand for energy. It has also helped Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate.

The importance of energy to Canadians and to the Canadian economy is evident in its direct contribution to economic activity. For example, energy makes up 6 per cent of our gross domestic product and 18 per cent of direct domestic investment. The economic importance of energy varies from region to region, but, wherever it is produced or used, it is fundamental to our way of life. Energy demand will tend to grow with the Canadian population and economy, moderated by improvements in the efficiency with which we use energy.

Primary energy use is the total requirement for all uses of energy. This includes energy used by consumers, in the transformation of one energy form to another, and by suppliers to deliver energy to the market. Primary energy use in Canada today reflects changes over the past two to three decades in energy-consuming equipment and buildings, and in the behaviour of energy users. From 1973 to 1992, primary energy use increased by 29 per cent,

The Energy Efficiency Act provides for the making and enforcement of regulations concerning energy efficiency and alternative energy.

from 7 143 petajoules (PJ) to 9 233 PJ (Figure 1.1). The share held by oil fell from 53 per cent to 36 per cent, while nuclear energy's share increased from two per cent to 10 per cent. Natural gas, coal and hydroelectricity also increased their share in primary energy use.

These changes occurred in response to economic and institutional factors, as well as factors directly related to the activities of the energy sector. In particular, they reflect the impact of two major oil price shocks and of government programs to promote energy conservation and oil substitution. These events also influenced energy intensity in Canada (Figure 1.2). Energy intensity is the amount of energy used per user — it is measured differently for different energy sectors. In the early 1980s energy intensity decreased as energy prices increased and government EAE programs were established. Energy prices peaked in 1985 and, since 1988, energy prices and intensity have remained relatively stable.

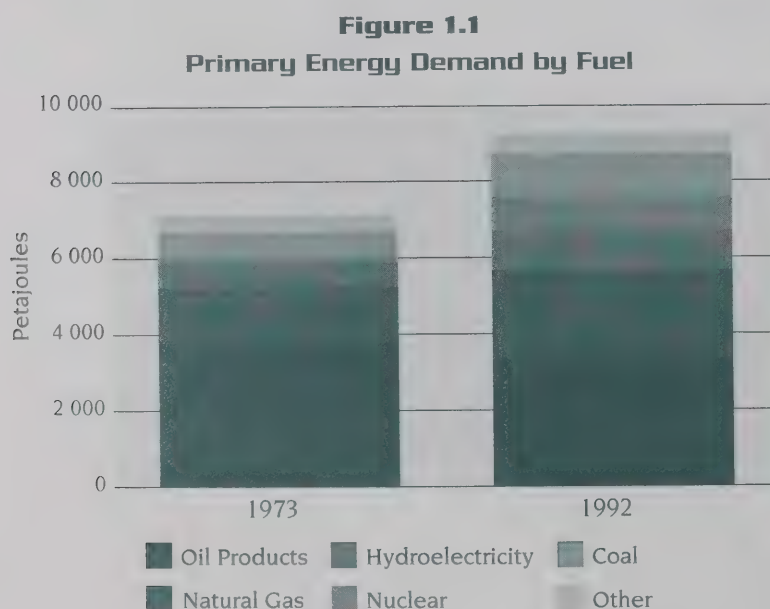
Secondary energy use refers to the energy used by final consumers in the residential, commercial, industrial and

transportation sectors. It accounted for 73 per cent of primary energy use in Canada in 1992 and grew from 6 122 PJ in 1978 to 6 722 PJ in 1992. Figure 1.3 shows each sector's share of total secondary energy use in those two years. The industrial sector has been the most significant energy user of the four, accounting for more than one third of total secondary energy use in both 1978 and 1992. The transportation sector has been and continues to be the second-largest energy user, followed by the residential (including farms) and commercial sectors.

■ **Energy Use and Atmospheric Emissions**

An important rationale for Canada's policies to encourage EAE is the reduction in the impacts that energy production and use have on the environment. It has long been recognized that the production, transportation and consumption of energy can significantly affect the environment. Industry and governments have taken numerous steps to reduce these environmental impacts (e.g., reducing the risk of water and land

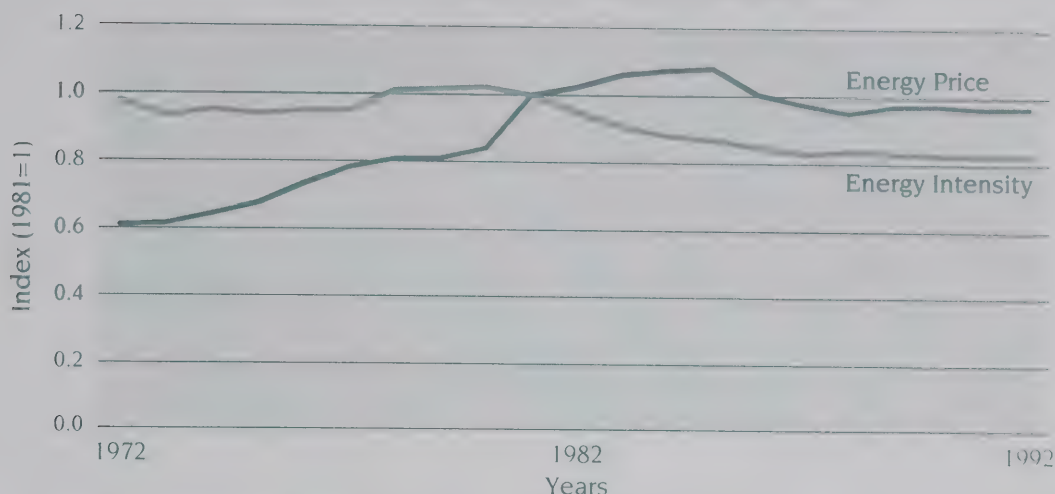
*Energy is fundamental
to our way of life.*



Sources: Statistics Canada and Natural Resources Canada, *Energy Statistics Handbook*, Cat. No. 57-601, 1994. Statistics Canada, "Quarterly Report on Energy Supply – Demand in Canada," Cat. No. 57-003, 1992-IV.

An important rationale for Canada's policies to encourage efficiency and alternative energy is the reduction in the impacts that energy production and use have on the environment.

Figure 1.2
Secondary Energy Intensity and Energy Price



Source: Natural Resources Canada.

contamination and the release of radiation from nuclear power plants). Recently, there has been growing concern about the effect of energy use on the atmosphere.

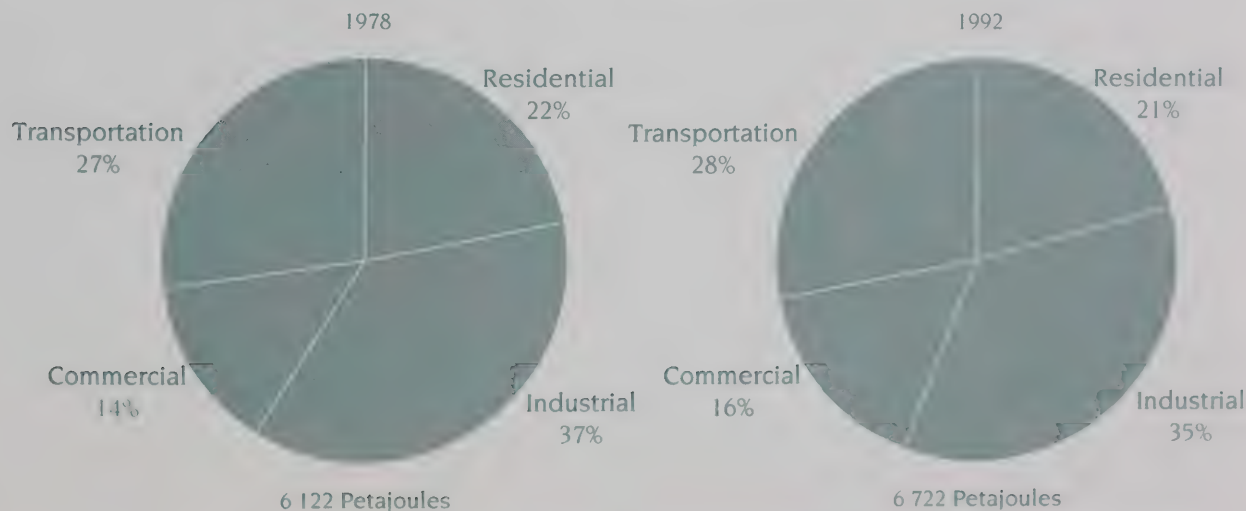
Producing, processing and using fossil fuels generates oxides of carbon, nitrogen and sulphur. In Canada, about 44 per cent of emissions of sulphur dioxide (SO₂) and 95 per cent of emissions of nitrogen oxides (NO_x) result from these activities. Fossil fuel supply and use also generate incompletely burned particles and volatile

organic compounds (VOCs). VOCs are formed mainly from the evaporation of liquid fuels, solvents and organic chemicals. About 60 per cent of VOC emissions in Canada is attributable to fossil fuels. These byproducts are the principal causes of acid rain, urban smog and potential climate change.

Acid Rain

Acid rain is caused by SO₂ and NO_x emissions. In the atmosphere, these gases can change into acidifying agents and return to the earth in rain, snow,

Figure 1.3
Secondary Energy Use by Sector



Source: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.

dust or fog, commonly referred to as acid rain. Acid rain increases the acidity of lakes, streams, ground water and soil, threatening wildlife populations and reducing the productivity of forests and agricultural lands. There is evidence that the pollutants carried by acid rain may contribute to respiratory problems in children and other susceptible groups. Acid rain also erodes buildings and can increase the levels of toxic materials, such as aluminum, copper and mercury, in untreated water.

In 1985, the federal government announced the Canadian Acid Rain Control Program. Under cooperative agreements with industry and the seven easternmost provinces, measures have been implemented to reduce SO₂ emissions. The goal in eastern Canada is to reduce emission levels to about 60 per cent of 1980 levels and maintain that level until 2000. For Canada as a whole, the objective is to reduce emissions to about 70 per cent of 1980 levels, by 2000. The first report on this program, released in June 1992, stated that by the end of 1990 more than 85 per cent of the goal for eastern Canada, and 70 per cent of the national goal, had been achieved.

Emissions of SO₂ and NO_x originate on both sides of the Canada-U.S. border from base metal smelting, petroleum processing, vehicles and burning coal to generate electricity. A Transboundary Air Quality Agreement, signed with the United States in March 1991, will help deal with the transboundary flow of acid rain.

Urban Smog

Ground-level ozone, a major component of urban smog, is formed in the lower atmosphere from a reaction between NO_x and VOCs in sunlight. More than one half of the Canadian population is regularly exposed to high concentrations of ground-level ozone in

the summer months. These concentrations are sometimes more than twice the Canadian maximum acceptable air quality objective for ozone and affect human health, crops and forests.

In 1990, the Canadian Council of Ministers of the Environment agreed in principle on a comprehensive 10-year management plan to control NO_x and VOC emissions. The document¹ sets out a number of interim targets; for example, by 2005, national NO_x emissions should be reduced by 11 per cent and VOC emissions by 16 per cent from 1985 emission levels, with reductions of about 25 to 40 per cent in the more serious areas. As with the acid rain program, cooperative implementation of the NO_x-VOCs Plan will involve federal-provincial agreements specifying the obligations of each party.

Global Warming

Greenhouse gases (GHGs) absorb and reradiate heat in the lower atmosphere that otherwise would be lost in space. This greenhouse effect is essential for life on this planet since it keeps average global temperatures high enough to support plant and animal growth. The main GHGs are carbon dioxide (CO₂), methane, CFCs and NO_x. By far the most abundant of the GHGs is CO₂; however, other GHGs absorb much more solar radiation per unit mass. Nevertheless, because of the enormous amount of CO₂ in the atmosphere compared with the other GHGs, CO₂ still accounts for about 70 per cent of the greenhouse effect (see Figure 1.4). Energy use is not a significant contributor to emissions of methane and CFCs; however, it accounts for about 98 per cent of CO₂ emissions.

In 1988, concern about the implications of dramatic increases in GHG emissions led to the establishment of the Intergovernmental Panel on Climate Change, under the auspices of the

Industry and governments have taken numerous steps to reduce environmental impacts.

¹ "Management Plan for Nitrogen Oxides (NO_x) and Volatile Organic Compounds (VOCs), Phase I," Canadian Council of Ministers of the Environment, November 1990.

World Meteorological Organization and the United Nations Environment Programme. In the autumn of 1990, the panel issued its report, predicting that the average temperature of the Earth would rise by about 0.3°C each decade over the next century. This is a significantly faster rate of increase than has been attributed to natural causes over the past 10 000 years.

This relatively rapid global warming could:

- raise sea levels, threatening coastal settlements;
- produce more heat waves and droughts; and
- shift climate zones so rapidly that many plant and animal species could not adjust quickly enough to survive.

At the Second World Climate Conference held in November 1990, Canada and a number of other countries committed themselves to stabilizing national emissions of CO₂ and other GHGs at 1990 levels by 2000. Canada is also committed to examining the feasibility and implications of reducing emissions further. In 1992, Canada and a number of other countries signed the United Nations' Framework Convention on Climate Change.

Lasting international solutions to the threat of global warming will take years to organize and implement. In the meantime, the Government of Canada has been working with the provinces and other stakeholders in addressing the problem of global warming by taking some first steps toward:

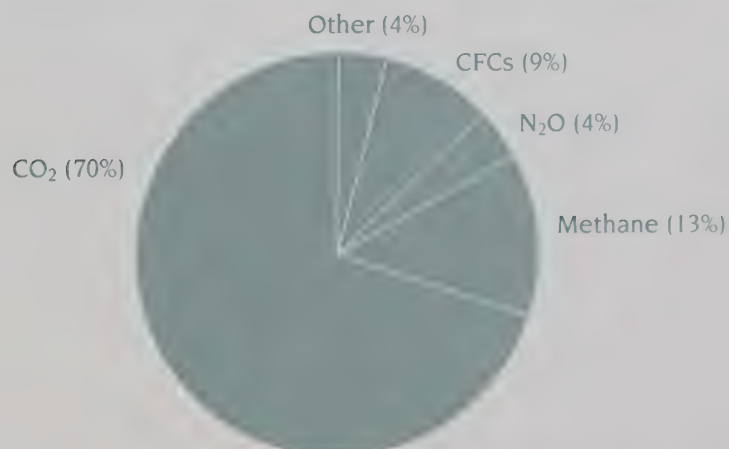
- limiting net emissions of GHGs;
- helping Canadians understand and adapt to the potential effects of global warming; and
- improving scientific understanding and the accuracy of predictions of climate change.

The Federal Approach to Efficiency and Alternative Energy

Since December 1990 when its intentions were outlined in the document Canada's Green Plan for a Healthy Environment, NRCan has been implementing its Efficiency and Alternative Energy Program as the federal government's first steps toward limiting GHG emissions. The program builds on several long-standing market promotion activities, such as EnerGuide and

In 1992, Canada and a number of other countries signed the United Nations' Framework Convention on Climate Change.

Figure 1.4
Greenhouse Gas Contribution to Global Warming



Source: Environment Canada, "Canada's Greenhouse Gas Emissions: Estimates for 1990," Dec. 1992.

R-2000, and on the research and development being conducted under the direction of the Panel on Energy Research and Development (PERD). The program also includes several new initiatives, such as energy-efficiency standards and the Energy Innovators Initiatives, which were developed by drawing on the department's long experience in designing and managing EAE programs. The program design takes into account:

- the need for flexibility as the program matures and our understanding of the implications of EAE opportunities and of global warming improves;
- international competitiveness and trade commitments; and
- the need for consistency with other policy objectives, especially fiscal restraint.

The program encourages investment in corporate and consumer EAE opportunities and seeks to engage all sectors of the economy and the public in the matter of energy use. It uses a variety of policy instruments, such as information, persuasion, R&D and regulation. In this

manner, the program helps the demand side of the energy market move toward more energy-efficient capital stock, production processes and operating practices, without reducing the level of service or comfort that energy currently provides. It also lays the foundation for longer-term processes that can respond to evolving environmental and economic development priorities by establishing enhanced statutory authority, improving data and analytical capabilities and forming stronger information and planning frameworks with the provinces and other strategic allies.

Although the federal government has identified many areas for improvement in EAE, the government cannot achieve sufficient progress on its own. Strategic alliances with the provinces in addressing climate change are crucial, given the number of important policy instruments that lie outside federal jurisdiction. Furthermore, EAE policy objectives require the participation of all Canadians, the acceptance of joint responsibility by all stakeholders and the continuous expansion of our options for managing energy supply and demand.

Strategic alliances with the provinces in addressing climate change are crucial, given the number of important policy instruments that lie outside federal jurisdiction.

The Role of Government

In general, markets operate efficiently. However, market imperfections exist and governments need to consider whether they can be partially or wholly removed to provide a net benefit to society. There appear to be profitable EAE investment opportunities available today that are unpursued. By realizing these opportunities, consumers can reduce their energy bills and business can improve its competitiveness. Environmentally, undertaking more EAE investment alleviates the need to use ever-increasing quantities of fossil fuels to meet our demand for energy services, thereby allowing Canada to meet its international commitment to limit its GHG emissions.

To achieve greater EAE, governments first need to address the barriers to the efficient functioning of the marketplace: inadequate information and knowledge, financial constraints and institutional deterrents. The following are some options for overcoming these impediments:

- In sales of energy-using products, such as household appliances, government can help to draw energy efficiency to the consumer's attention over a product's other attributes, such as colour or optional extras, which frequently are more visible and heavily advertised. Government can help consumers understand the energy costs and environmental impacts attached to their decisions by providing relevant, usable information and encouraging consumers to look at the long-term effects of their decisions on society.

- Companies have numerous options for improving their financial position and ability to compete. Government can help increase the level of funds allocated for EAE investments (within private and public fiscal limits) by facilitating energy-use audits, distributing information on new technologies and helping companies train their staff.
- Government regulators are traditionally concerned about utilities operating at minimum cost. Hence, it is within established practice to ensure that utility systems are used efficiently. In general, regulators have accepted the need to examine the environmental impacts of utility expansion and to consider alternative approaches offered by demand side management (DSM) and integrated resource planning.
- Governments can identify institutional deterrents and discuss with stakeholders how to reduce or offset them.

The most effective policies usually offer the greatest flexibility to those affected by the policy. Centralized policy instruments may provide more assurance that targets will be met, but they can restrict flexibility and the ability to take advantage of local capacities and opportunities. Ultimately, policy makers must balance commitment with flexibility, a participatory approach with central authority, and environmental imperatives with other economic and social objectives.

Undertaking more energy-efficiency and alternative energy investment alleviates the need to use ever-increasing quantities of fossil fuels to meet our demand for energy services.

Market Barriers to Energy Efficiency and Alternative Energy

Market Considerations

In general, energy markets ensure that energy is consumed, produced and traded reasonably efficiently. However, the consumption of energy in total, and of specific types of energy, may be greater or less than what is economically optimal if there are barriers discouraging profitable investment in greater EAE.

There is considerable ongoing debate about the barriers to EAE opportunities in terms of their overall significance and pervasiveness. The most commonly identified barriers are described below.

Inadequate Information and Knowledge

Buyers of equipment, vehicles or buildings often do not know which models are more energy-efficient and how much money they could save with them. Similarly, people often waste energy in the way they use energy-consuming products, or they overlook opportunities to make energy-saving retrofits, because they do not fully appreciate the long-term benefits. This is particularly true for householders who generally are unable to perceive, evaluate or proceed with these investment opportunities. Learning more about energy efficiency can be difficult, expensive (given other budget priorities) and time-consuming. Hence, private individuals tend to be even more cautious with the unfamiliar and uncertain than are most private firms, making them less inclined to make even the smallest investment in greater energy efficiency.

Commercial and industrial energy consumers are generally better informed about their energy costs than are householders. However, insufficient technical

knowledge can deter them from adopting EAE technologies. This also leads to poor operation of equipment and unnecessary energy use, particularly in the case of newly developed products and processes where it may be difficult for a company to find trained operators and maintenance personnel and too expensive to train their staff.

Financial and Economic Constraints

Cash flow and credit limitations may mean that individuals or firms demand a very quick payback on their investments. This may lead to a bias against EAE investments, which are frequently characterized by a high upfront cost. As well, in large parts of the residential and commercial sectors, the current length of occupancy constrains building improvements to projects with rapid paybacks. Moreover, when the owner of an energy-efficient asset (e.g., a house, car or factory) wants to sell it, he or she may be unable to regain his or her investment in this asset's energy efficiency.

Institutional Deterrents

Institutional deterrents arise from the way energy markets are organized. For example, in industry, beneficial R&D or infrastructure development may not be pursued because the resulting benefits to society do not go to the company making the investment. In the residential and commercial sectors, builders typically are concerned only with construction costs and not with the cost of using the structures they create. Buyers and tenants often are more concerned with other aspects of a building than its energy use, which in any event may seem small in comparison with the purchase price or rent. Another institutional deterrent is the practice of paying for energy use out of apartment rents, giving tenants no financial incentive to use energy more efficiently.

Buyers and tenants often are more concerned with other aspects of a building than its energy use.

Energy Efficiency Strategy

Many of NRCan's EAE initiatives deal solely with energy efficiency. These are presented in chapters four through seven according to end-use sector: buildings, equipment, industry and transportation. Energy efficiency can be improved by:

- upgrading the energy efficiency of new and existing equipment, vehicles, systems and buildings that consume energy;
- ensuring that energy-consuming appliances and equipment are used in the most energy-efficient way (e.g., keeping furnaces well-tuned, operating vehicles at optimal speeds);
- influencing the choices of individuals and organizations (e.g., to use public transit instead of personal vehicles); and
- modifying the daily energy-use practices of individuals and organizations.

The key policy tools employed by NRCan are:

- regulatory strategy — setting minimum energy-efficiency standards for certain types of equipment and buildings (with provincial governments);

- information strategy — targeting information programs to specific groups of energy consumers;
- persuasion strategy — setting energy-efficiency objectives for vehicles, companies and institutions; and
- R&D strategy — providing support for development and deployment of more energy-efficient equipment, processes and technologies.

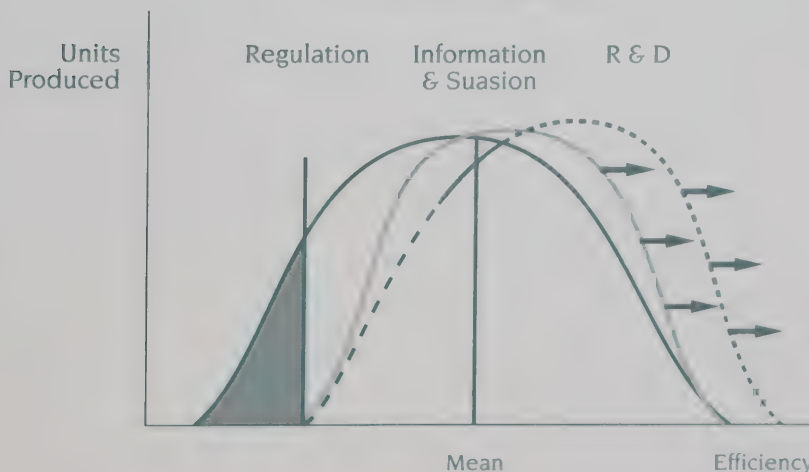
Figure 2.1 shows how these policy tools work together to reduce the amount of energy needed to obtain a certain level of service. Regulations eliminate the least energy-efficient items (the "laggards") from the marketplace. Information and persuasion convinces consumers to purchase the most energy-efficient items available and to use them correctly. R&D contributes by continually providing new technologies that increase the level of energy efficiency consumers can achieve.

Alternative Energy Strategy

Alternative energy includes nonconventional renewable sources of energy (e.g., bioenergy, solar) and new applications of conventional energy sources (e.g., natural gas used as an automotive fuel). Some technologies, especially for

Information and persuasion convinces consumers to purchase the most energy-efficient items available and to use them correctly.

Figure 2.1
Moving the Market



propane and forestry biomass, are commercially available and accepted. Some have found applications in specialized markets, such as remote communities. Still other technologies are in the early stages of development. Chapter eight describes measures NRCan has under way to help develop and encourage the use of alternative sources of energy.

NRCan's alternative energy activities are directed toward the most technically promising alternatives that have good potential for significant market application. These include alternative transportation fuels (ATFs), particularly propane, natural gas, methanol and ethanol. Federal initiatives are helping to expand the infrastructure for these fuels and their markets, especially in

regions with air quality problems that can be alleviated through greater use of ATFs. R&D is ongoing to improve the near- and long-term ATF options.

Renewable energy sources, such as solar and wind technologies, hydraulics and bioenergy, are generally recognized as important potential contributors to the long-term resolution of global warming concerns. NRCan's support for renewable energy is allocated largely to R&D to reduce costs, improve performance, develop safety and performance standards, and increase the scope for application of renewable energy technologies. Other activities involve providing reliable information to potential buyers and assessing economic and environmental factors.

Renewable energy sources are generally recognized as important potential contributors to the long-term resolution of global warming concerns.

Efficiency and Alternative Energy Programs

Overview

Chapters one and two set out the context and policy framework for NRCan's EAE program initiatives. The remaining chapters three to eight describe each of NRCan's 33 EAE program initiatives. Chapter three outlines four initiatives of a "cross-cutting" or horizontal nature. Chapters four to seven detail 20 energy-efficiency initiatives in the four sectors that use energy: buildings, equipment, industry and transportation. Chapter eight sets out program initiatives geared to increasing the use of alternative energy: five initiatives on alternative transportation fuels (ATFs) and four on renewable energy. In each of chapters four to eight, introductory sections explain how energy is used and recent developments in that area of energy use.

For each of the 33 EAE program initiatives, this report sets out their:

- purpose — what they are trying to achieve;
- activities — what they do to achieve their purpose; and
- achievements during the reporting period for this report, September 1, 1992 (when section 21 of the *Energy Efficiency Act* came into force) to March 31, 1993.

In undertaking its EAE program activities, NRCan cooperates closely with provincial and territorial departments of energy. This work takes place on several levels:

- NRCan managers and staff working with their provincial and territorial counterparts on a specific program initiative;
- NRCan developing a bilateral relationship with interested provinces or territories in terms of the overall delivery of EAE program initiatives; and
- NRCan participating in the intergovernmental Conservation and Renewable Energy Subcommittee (CARES) under the Advisory Committee on Energy.

Other federal programs foster EAE beyond the NRCan EAE initiatives outlined in this report. For example, other federal departments conduct EAE research activities under the Panel on Energy Research and Development (PERD). Tax relief measures, such as the absence of a fuel excise tax on natural gas, propane, neat methanol, ethanol and the alcohol portion in ethanol- and methanol-gasoline blends, are another support.

Table 3.1
EAE Initiatives and Expenditures for 1992-93 (\$ million)

Comprehensive Programs	5.5	Industry Energy R&D	
Consumer Information		Industrial Targeted R&D	
Partnership in Integrated Resource Planning		Gas Technologies Program	
Advanced Integrated Energy Systems Technologies Initiative		Transportation	2.4
National Energy Use Database		Motor Vehicle Fuel Consumption Standards	
Buildings	8.8	Transportation Energy Efficiency	
Federal Buildings Initiative		Transportation Efficiency R&D Program	
National Energy Codes for Buildings and Houses		Alternative Energy: Alternative Transportation Fuels	8.2
R-2000 Home Program		Propane	
Energy Innovators Initiative		Natural Gas	
Building Information Transfer		Methanol	
Federal Industrial Boiler Program		Ethanol	
Buildings Energy Technology Advancement Plan		Alternative Transportation Fuels R&D Program	
- Residential		Alternative Energy: Renewable Energy Sources	9.1
- Commercial		Renewable Energy Market Assessments	
- Passive Solar		Information and Awareness	
Heat Management Program		Canada - Prince Edward Island Cooperation Agreement on Alternative Energy Development and Energy Efficiency	
Equipment	1.9	Renewable Energy Technologies Program	
Efficiency Standards for Equipment		TOTAL	44.5
EnerGuide			
Industry	8.6		
Industrial Energy Efficiency			
Canadian Energy Management and Environmental Training Program			

The table above presents actual NRCan expenditures during fiscal year 1992-93 on EAE initiatives by end-use sector or by type of alternative energy (several initiatives that cover all sectors are listed as "comprehensive programs"). The expenditures are based on funds received from several sources: the Green Plan, Panel on Energy R&D, A-base (basic operating budget) and sunsetted programs (those with established completion dates).

Consumer Information

Purpose

To make Canadians aware of the link between energy use and the environment and to encourage the use of energy-efficient practices and alternative forms of energy.

Activities

NRCan is engaged in a broad range of marketing activities designed to promote EAE. NRCan produces and markets numerous publications aimed at the public, as well as more specific audiences. Publications offer information on a wide range of topics, from how to make a home more energy-efficient to how to select an energy-efficient car, heating system, appliance or lighting product. In addition to general interest materials, this initiative produces program documentation and promotional products.

Marketing efforts also include an extensive program of exhibits featuring EAE initiatives such as R-2000, EnerGuide, the National Energy Code, the Federal Buildings Initiative, Energy Innovators and Transportation Energy Efficiency. Exhibits go all over the country and appear at home and auto shows, regional expositions and specialized trade shows.

This initiative also provides marketing support for all of the other EAE programs described in this document.

Achievements in 1992-93¹

- Distributed more than 1.5 million copies of the 300-plus EAE titles either directly to individuals or through program allies.

- Broadcast a series of five animated public service announcements using the Energy Cat, a character that reminds Canadians to use energy efficiently in their homes, keep their cars tuned to reduce harmful emissions and use public transportation and car pools. These 30-second announcements were broadcast by television stations across the country.
- Produced a series of magazine articles for use in newspaper supplements, on home energy improvements, purchasing energy-efficient appliances, driving efficiently and the R-2000 Home, in collaboration with Environment Canada and PowerSmart utilities. The supplement material was offered to all weekly and ethnic newspapers nationwide, and was requested by most dailies. NRCan collaborated with some of these strategic allies on the production of a special edition of a magazine insert that was delivered to almost two million Canadian households.

Partnership in Integrated Resource Planning

Purpose

To increase the adoption of integrated resource planning and the implementation of demand side management (DSM) policies, planning and programming among the various energy utilities in Canada and to facilitate the coordination of federal government programs and energy-efficiency programs and projects involving provincial governments, utilities and the energy-efficiency service industry.

¹ Achievements described throughout this report cover the period from September 1, 1992 to March 31, 1993

Activities

Partnership in Integrated Resource Planning (PIRP) works directly with associations, energy utilities, manufacturers, suppliers, installers and financiers of energy-efficiency products and services. PIRP activities are related to other EAE program elements in that they initiate cooperative solutions to address gaps in energy-efficiency initiatives.

PIRP also works with energy utilities in Canada in order to increase the adoption of integrated resource planning and the use of energy efficiency as an alternative to the development of new energy supplies.

Achievements in 1992-93

- Cooperated with the Canadian Electrical Association in the convening of a conference addressing supply and demand options facing Canada's electrical utilities on the eve of the 21st century. This marked the first occasion on which the association convened conference sessions with stakeholders and customers from the residential, commercial and industrial sectors to provide Canadian electrical utilities with a basic dialogue on wants, needs and concerns related to future use of electricity.
- Assisted the Canadian Electrical Association in the publication of the book *Demand Side Management in Canada*, 1992, a compendium of DSM policies, programs, activities and targets of Canada's electrical utilities. Other work with the association included assistance in the design and delivery of DSM workshops and seminars for utility planning staff, a study of the impact of DSM programs on utility emissions and a DSM training needs analysis.
- Supported the national energy-efficiency marketing efforts of PowerSmart Inc., as well as sponsoring

a study on the use of remote signalling for DSM programs involving peak clipping and interruptible power.

- Assisted Alberta Power in the Jasper Energy-Efficiency Pilot Project, which successfully demonstrated how the pursuit of energy-efficiency opportunities could postpone the need for generation expansion.
- Developed a network of allies in the energy management industry, including companies able to provide turnkey energy management services (engineering, construction and innovative financing techniques) to customers in the commercial and institutional sectors.

Advanced Integrated Energy Systems Technologies Initiative

Purpose

To identify barriers to the implementation of integrated community energy systems and to provide information on how to overcome these barriers.

Activities

Integrated community energy systems present an opportunity to reduce energy costs, increase energy efficiency and simultaneously reduce atmospheric emissions, such as CO₂, in the distribution and use of low-temperature heat from power stations and other energy generation systems. An integrated community energy system might involve a network of pipes to circulate water that can recover heat from sources such as power generating stations, industrial-cooling water or wood-waste boilers and use it for space and hot-water heating of buildings. Conversely, the piping network may couple buildings with lake water to provide cooling. These technologies are now standard in Europe.

Integrated community energy systems are now standard in Europe.

Under this initiative, NRCan develops information to illustrate the technical aspects of integrated energy systems and their environmental and economic benefits for communities. This includes design tools for engineers, promotional material, environmental reports and seminars or workshops, focusing on genuine opportunities for implementation.

Principal clients include:

- municipal officials, who may not understand the economic, environmental and energy implications of community energy systems and therefore have broader information requirements;
- electric utilities, who reject over 60 per cent of the thermal energy that passes through the turbines to produce electricity, can modify the turbines and condensers to reject the heat at a higher temperature and sell the heat to communities, instead of discharging it to the lake or river as cooling water;
- engineers, who need more information on new technology in district energy; and
- provincial policy makers, who have not included integrated energy systems as part of their energy planning.

Organizations whose support for community energy systems technology may be critical include electrical utilities and their associations; the Canadian Electrical Association; municipalities, directly or through the Federation of Canadian Municipalities; provincial governments; and ministries of municipal affairs, economic development and environment. NRCan has working relationships with these organizations to develop joint strategies for implementing such systems to increase energy end-use efficiency.

NRCan identifies municipal and utility opportunities and evaluates the merits of integrated community energy system

approaches. When other levels of government provide funding, the Canada Centre for Mineral and Energy Technology (CANMET) provides technical advice or guidance.

NRCan works with existing integrated energy utilities, including the organization of information seminars, to ensure that the utilities are aware of the most recent international developments. To give utilities input on the direction of the Advanced Integrated Energy Systems Technologies Initiative, the department provides a forum for information exchange.

The department also advises provincial and other government departments on how to effectively incorporate energy systems into their planning process.

Achievements in 1992-93

- Constructed North America's first plastic pipe district heating system using versatile plastic pipe for transferring and distributing heat, in the Cree village of Oujé-Bougoumou in northern Quebec.
- Completed a major study with the Canadian Electrical Association to demonstrate that the conversion of existing thermoelectric power plants to combined heat and power operation is economically attractive. As a result, two utilities have incorporated community energy systems into their planning.
- Conducted a preliminary study for the City of Ottawa to demonstrate community energy system options that would be viable and would allow building owners to replace existing CFC chillers with non-CFC-based central cooling.
- Reached an agreement with the Province of Ontario, the City of Metropolitan Toronto and Ontario Hydro to investigate the extent to which a community energy system

could be established in the Metro Toronto area using the heat from area thermoelectric plants.

- Established, with the Federation of Canadian Municipalities, a Working Group on District Energy to investigate the merits of community energy systems and to identify strategies to promote and implement these systems.

National Energy Use Database

Purpose

To improve the state of knowledge on energy consumption at the end-use level in Canada.

Activities

This initiative enables the federal government to evaluate its progress in limiting GHG emissions and provides information to support the development of further EAE initiatives. It does this through the establishment of processes for the regular collection of reliable national data on energy consumption at the end-use level, the characteristics of energy-using equipment and buildings, the attitude and behaviour of Canadian consumers toward energy use, the adoption of energy-efficient technologies and the analysis of these data. The National Energy Use Database (NEUD) reviews existing data sources in each end-use sector, assesses data needs, and expands existing data surveys or creates new surveys as required.

NEUD facilitates the creation of energy end-use data and analysis centres for specific energy-consuming sectors, where the national database can be stored and made easily available to researchers. These centres compile, organize and analyze existing energy end-use data and advise NRCan on the creation of new data sources.

Achievements in 1992-93

- Completed field collection for the first Survey of Household Energy Use. This survey will provide information on the energy characteristics of household equipment and housing, and on the circumstances or factors affecting energy consumption. The survey is conducted by Statistics Canada for NRCan, as a supplement to Statistics Canada's Labour Force Survey. The Survey of Household Energy Use is the first national survey on this topic.
- Contributed to expanding the energy-consumption questions on the 1992 Household Facilities Survey. Statistics Canada was planning to drop heating system questions from the next Household Facilities survey, but NRCan requested that these questions be kept in and others be added concerning the use of dual-fuel systems and heat pumps. This information is essential to estimating residential energy consumption and evaluating potential energy savings.
- Funded the processing of detailed energy-use data from the 1991 Survey of Manufacturers, data available for the first time since 1986. All related fuel data have been processed by Statistics Canada and are now available to energy analysts.
- Created a Canadian database and analysis centre on energy use of private vehicles at Université Laval. The Automobile Mobility Data Compendium aims to improve the accessibility and comparability of existing data on the evolution of private-vehicle use and its impact on personal mobility, energy consumption and environmental quality. Through the compendium, NRCan plans to make past and present national and international databases accessible to analysts and to provide technical expertise and professional services.

The National Energy Use Database enables the federal government to evaluate its progress in limiting greenhouse gas emissions.

-
- Established the Canadian Industry End-Use Database and Analysis Centre, within Simon Fraser University's School of Resource and Environmental Management. The Energy Research Group has acquired an international reputation for energy

end-use data collection and modelling, especially in the industrial sector. The Simon Fraser centre will pursue the same objectives as the Laval compendium in the area of industrial energy end-use.

*The Survey of
Household Energy Use
is the first national
survey on this topic.*

Building Energy Use

A building is a system comprising a building envelope, architectural features, mechanical equipment and occupants. The building envelope is made up of all the materials and surfaces in the building shell, including walls, ceilings, roof, basement walls, windows and doors. The architectural features determine the degree to which the building gets energy from the sun. Mechanical equipment is the energy-using component of the system and includes all the equipment and appliances related to space heating and cooling, ventilation, lighting, water heating, cooking and humidifying. The interaction of the building envelope, the architectural features, the mechanical

equipment and the energy practices of the occupants determines the overall energy use of the building. This chapter focuses on these aspects of energy efficiency.

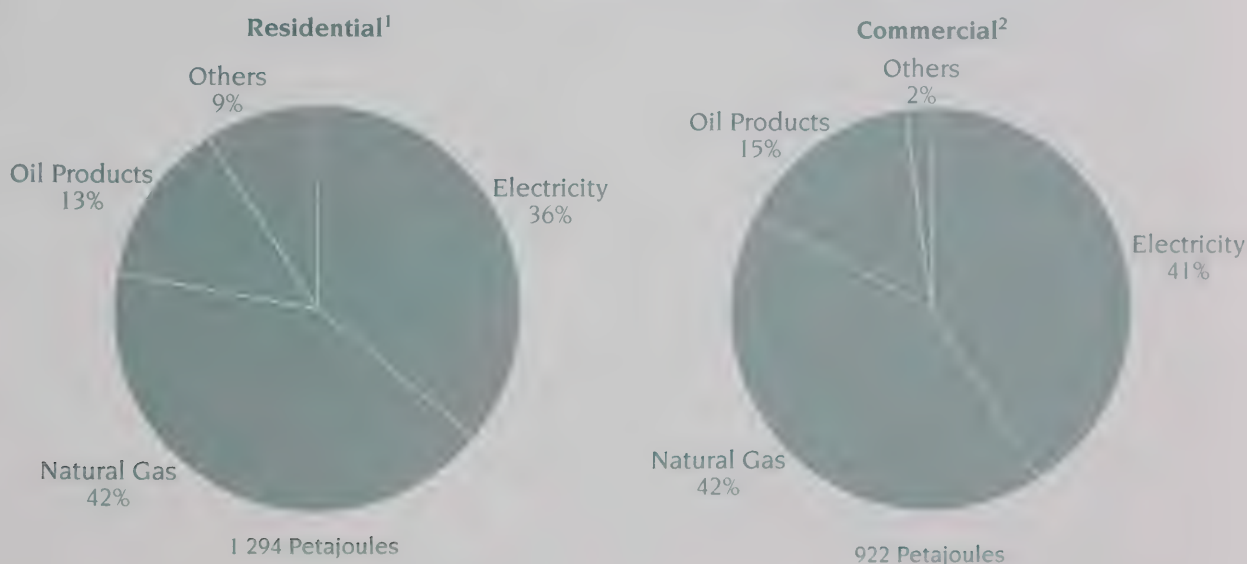
Energy use in residential and commercial buildings in 1992 amounted to some 2 216 PJ, equal to 33 per cent of total Canadian energy use. Residential buildings accounted for approximately 1 294 PJ (19 per cent of secondary energy use), while commercial buildings accounted for approximately 922 PJ (14 per cent of secondary energy use).

Although residential and commercial buildings differ substantially in the way they consume energy, they are similar in the fuel mix they use (see Figure 4.1).

Energy use in
residential and
commercial buildings
in 1992 amounted
to 33 per cent
of total Canadian
energy use.

Figure 4.1

Residential and Commercial Energy Use by Fuel - 1992



1 - Excludes farm motive use.

2 - Excludes aviation fuels, diesel fuel oil and motor gasoline.

Sources: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.

Natural Resources Canada, Residential End Use Model.

Natural Resources Canada, Commercial End Use Model.

Natural gas is the dominant fuel in the residential and commercial sectors, accounting for 42 per cent of energy use in each sector.

In the residential sector, electricity accounts for the second-largest share (36 per cent). Oil accounts for the third-largest share (13 per cent) of residential energy use.

In the commercial sector, the importance of electricity has increased throughout the decade and now represents some 41 per cent of energy use. Oil accounts for approximately 15 per cent of commercial energy use.

Canadian residential and commercial building energy use are compared for different building types in Figure 4.2. In the residential sector, family homes are the major energy-using group. In the commercial sector, energy use occurs in diverse market segments and building types, with retail, education and office buildings accounting for more than one half of commercial energy use.

Developments in Energy Efficiency

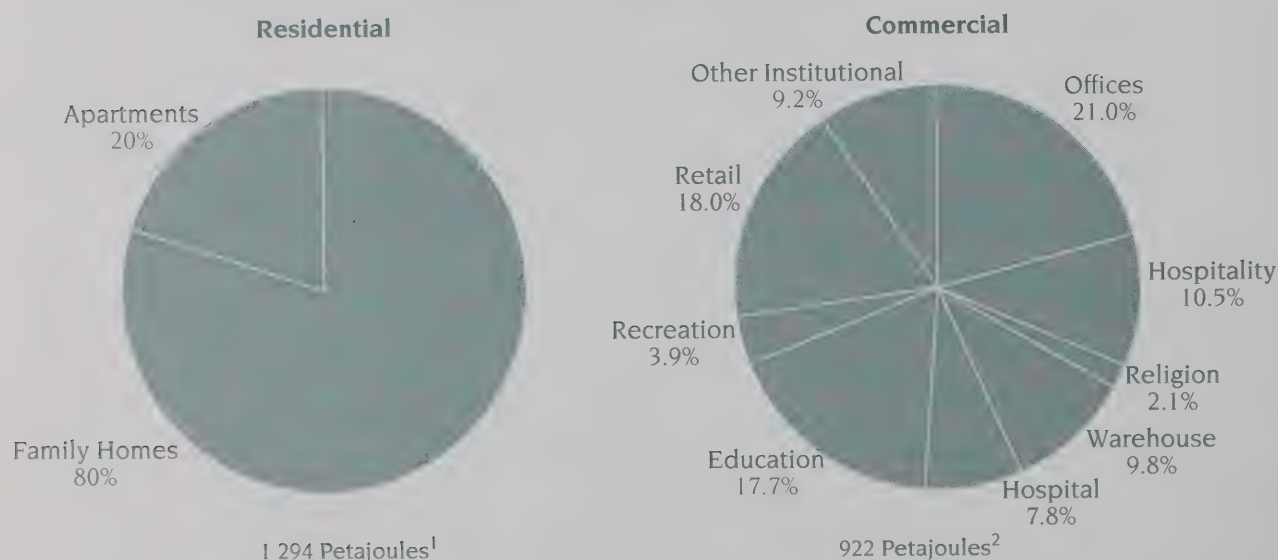
Over the past 15 years, governments have begun to include energy-efficiency standards in building codes. Most new houses are now built to levels recommended in the 1983 *Measures for Energy Conservation*. The market penetration of highly energy-efficient buildings remains low. Highly energy-efficient R-2000 Homes make up about two per cent of all new units.

Advanced Houses — super energy-efficient homes meant to test emerging energy-efficient housing technologies — have been built in various cities. These represent the energy-efficient houses of the future.

Figure 4.3 illustrates the energy use and thermal performance of major Canadian building design options: the 1978 and 1983 *Measures* and the R-2000 Technical Standard. The comparison shows how much thermal performance has improved.

Natural gas is the dominant fuel in the residential and commercial sectors.

Figure 4.2
Residential and Commercial Energy Use by Building Type - 1992



1 - Excludes farm motive use.

2 - Excludes aviation fuels, diesel fuel oil and motor gasoline

Sources: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.

Natural Resources Canada, Residential End Use Model.

Natural Resources Canada, Commercial End Use Model.

Figure 4.3
Average Space Heating Requirements
for New Single Family Homes by Selected Thermal Archetypes



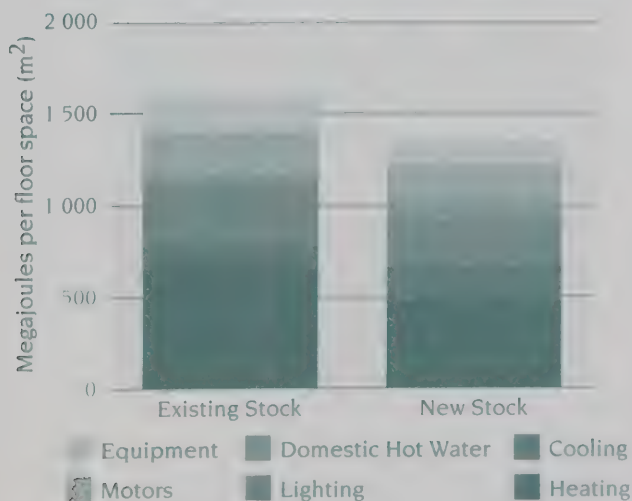
Source: Peat Marwick Stevenson and Kellogg, "The Economically Attractive Potential for Energy Efficiency Gains in Canada," May, 1991.

Over the past
15 years, governments
have begun to include
energy-efficiency
standards in building
codes.

Standard commercial building construction over the past 50 years has relied on concrete and metal framing (for structural support) with a variety of outer skin materials. Building envelopes vary from all glass to no glass, while exteriors range from concrete to brick to new composites. Energy-efficient buildings use conventional measures, such as increased

insulation, improved airtightness and controlled ventilation, to reduce their energy requirements. The introduction of energy-efficient building practices over the past decade has resulted in steadily declining energy use per square metre of commercial buildings. As illustrated in Figure 4.4, the output energy efficiency of today's new buildings is almost 16 per cent less than that

Figure 4.4
Commercial Sector Output Energy Intensity
by Building Vintage and End Use - 1992



Source: Natural Resources Canada, Commercial End Use Model

of the existing stock of buildings. Much of this decline can be attributed to reduced space-heating requirements (a result of improved building envelope design and more efficient heating systems) and reduced energy requirements for lighting (owing to the use of more efficient fluorescent lamps). These changes result from the promotion of more energy-efficient building practices by professional advocacies, institutional groups and stakeholders such as the Energy Management Task Force. Furthermore, some jurisdictions (e.g., the City of Vancouver) have put energy-efficiency requirements in their building practices.

Federal Buildings Initiative

Purpose

To help government departments and agencies improve the energy efficiency of their facilities.

Activities

The Federal Buildings Initiative provides a full package of products and services for federal departments and agencies seeking to upgrade the energy efficiency of their approximately 50 000 facilities. The key feature of the initiative is a mechanism that allows departments and agencies to fund energy-efficiency improvements from their energy budgets, which precludes the need for capital funding. The cost of the improvements is recovered from the energy savings.

The Federal Buildings Initiative establishes strategic alliances with utilities, the energy management industry and energy-efficient product manufacturers to facilitate the implementation of the program in federal departments. A National Management Committee for the initiative, composed of representatives from each federal department and a series of regional implementation committees, facilitate program delivery.

Achievements in 1992-93

- Prepared a pre-qualified bidders list of energy management firms that had the technical and financial resources to participate in the initiative.
- Developed model energy service contracts and requests for proposals for use by federal departments for energy-efficiency projects.
- Initiated a Quick Start campaign to target federal departments to expedite the implementation of energy-efficiency projects.
- Established strategic alliances with utilities and industry associations.

National Energy Codes for Buildings and Houses

Purpose

To increase the energy efficiency of Canadian buildings by specifying minimum levels of thermal performance and promoting the incorporation of these codes into provincial and municipal building regulations.

Activities

After extensive consultation with the Provincial-Territorial Committee on Building Standards and provincial and territorial ministries of energy, NRCan is contributing to the development of a model code for energy efficiency in new buildings to replace the 1983 *Measures for Energy Conservation*. As a result, the 1995 *National Building Code of Canada* will contain a new section entitled *Energy Efficiency*. This new part will reference *The National Energy Code for Buildings*, and *The National Energy Code for Houses*, which have been prepared as draft model codes containing prescribed energy building standards for the provinces and territories.

These model codes will provide economically justified thermal performance

Model codes will provide economically justified thermal performance levels based on regional construction costs, energy prices and climate.

levels based on regional construction costs, energy prices and climate. They will be available in both prescriptive- and performance-based versions. The codes were developed by a standing committee under the Canadian Commission on Building and Fire Codes, and were funded by NRCan, the Canadian Electrical Association, the provincial and territorial ministries of energy, and the National Research Council.

Achievements in 1992-93

- Funded research for the energy codes, with utilities, provincial ministries of energy and other stakeholders.
- Assessed the economic impact of the minimum standards set out in the new energy codes.
- Funded the development of Houstrad, a computer software program that permits more design flexibility in meeting thermal requirements and can be used with the *National Energy Code for Houses*.
- Developed promotional materials for the National Energy Codes, including an exhibit and brochures, which are directed at builders, designers and other authorities in the construction industry.
- Participated in an industry-led committee investigating building labelling for houses in Canada and completed a study on receptiveness to building labelling in the commercial building sector.

R-2000 Home Program

Purpose

To increase the energy efficiency of new homes.

Activities

The R-2000 Home Program develops a standard of energy efficiency in housing that exceeds those in current building codes. The standard is voluntary and is applied in addition to all required building codes and regulations. Ongoing research by NRCan and others ensures that the R-2000 standard evolves and maintains its position at the leading edge of housing technology.

The program trains house builders to construct to the R-2000 standard, and it tests and certifies the houses. A promotional element encourages home purchasers to consider the R-2000 standard. The program is managed nationally by NRCan but is delivered through strategic alliances that typically comprise energy utilities, provincial governments, provincial home builder associations, financial institutions and others.

Achievements in 1992-93

- More than 1 200 R-2000 Homes were built during 1992-93, the biggest year ever for the program. More than 6 000 R-2000 Homes have been built since the program started in the early 1980s.
- Trained more than 800 builders, bringing the total number of builders trained since the program began to more than 5 000.
- Established R-2000 programs in four provinces during the fiscal year. R-2000 offices are now operating in all provinces except Saskatchewan and Alberta. In New Brunswick, all social housing is built to the R-2000 standard.
- The first R-2000 Home in Japan was built under a licensing agreement with NRCan.

The R-2000 Home Program develops a standard of energy efficiency in housing that exceeds those in current building codes.

Energy Innovators Initiative

Purpose

To encourage the corporate, institutional and municipal sectors of Canada to become more energy efficient.

Activities

NRCan helps organizations overcome the obstacles to energy-efficiency projects or approach energy efficiency in a comprehensive, systematic way. This is accomplished by working with a national network of allies (e.g., energy service companies, manufacturers, electrical and gas utilities, other federal departments and levels of government, and national associations). National organizations are recruited to join the Energy Innovators Initiative through voluntary corporate commitments made at the CEO level.

NRCan's strategy is to make use of economies of scale in the promotion of energy efficiency, through the identification of generic energy-efficiency opportunities that can be pursued on an organization-wide and sector-wide basis. To this end, NRCan focuses on pilot projects within an innovating organization, that can be applied to other sites of the innovating organization or to similar businesses. Sectoral action groups have been established to identify issues. Generic service packages are developed in response. At the same time, the innovating organizations, which hold membership in the various action groups, can implement their pilot projects through the development and delivery of customized service packages. The successes of Energy Innovators are celebrated with awards and media publicity sponsored by NRCan.

Achievement in 1992-93

- Recruited 47 organizations (representing more than 27.8 million square metres of floor area) to become Energy Innovators.

Building Information Transfer

Purpose

To provide information that encourages adoption of energy-efficient products and practices in the building sector.

Activities

The availability of energy-efficiency information is assessed and material is developed to fill information gaps. For example, Canadians have found it difficult to obtain understandable, verified information on the energy performance of windows. The window market is an active one and significant energy savings are possible with the proper choice, but the information to make that choice has not been readily available.

Achievements in 1992-93

- Contributed to industry efforts to develop and deliver a certification and energy labelling program for windows and patio doors, endorsed by the general membership of the Canadian Window and Door Manufacturers Association. NRCan funded marketing research to identify support for the program and helped develop promotional strategies and materials to encourage subscription to the program by manufacturers and use by consumers.

Federal Industrial Boiler Program

Purpose

To assist in the development and use of clean, energy-efficient combustion technologies in federally owned boilers.

Activities

The Canadian government owns 52 central heating plants, which house about 270 boilers. These boilers consume more than 1 800 terajoules of fuel and produce more than 650 tonnes of NO_x emissions annually.

NRCan's strategy is to make use of economies of scale in the promotion of energy efficiency.

The Federal Industrial Boiler Program (FIBP), managed by CANMET, provides federal departments with services to increase energy efficiency, reduce NO_x emissions and extend the useful life of existing boiler systems and auxiliary equipment. The program ensures that energy-efficient and environmentally responsible technologies are considered in replacements of, or modifications to, industrial heating plants.

Along with developing site-specific strategies to assist boiler operators to meet higher equipment performance targets, FIBP provides turnkey project management services on new or retrofit combustion technologies. These services include preparing technical specifications, reviewing tenders and overseeing the installation and commissioning of new equipment. Services also include cogeneration feasibility studies, retrofit studies, non-destructive examinations of existing heating plant equipment, life-cycle cost studies, on-site test burns, and technical workshops and seminars. FIBP services are available to all Crown corporations and agencies of the federal government. The program charges for its services.

Achievements in 1992-93

- Obtained a contract from the Department of National Defence to manage heating plant retrofit projects for improved energy efficiency and NO_x reduction at CFB Trenton (Ontario), CFB Uplands (Ontario) and CFB Greenwood (Nova Scotia). New boilers, controls, fans and low NO_x burners were installed. At CFB Trenton, NO_x emissions were cut in half (7.3 tonnes displaced annually) and fuel consumption was reduced by 3 per cent, saving \$24 000 annually. The retrofit of CFB Uplands' summer boiler resulted in a 50 per cent NO_x reduction (2.5 tonnes displaced annually) and fuel savings totalling \$3 240 annually. The installation of new controls at CFB Greenwood decreased annual fuel costs by \$30 000.

- Managed the installation of three low NO_x burners at Agriculture and Agri-Food Canada's heating plant in Nepean, Ontario. The retrofit reduced NO_x emissions by 50 per cent (2.4 tonnes displaced annually) and reduced fuel costs by 4 per cent, saving \$12 000 annually.
- Completed site-specific services for clients: seven retrofit surveys, two non-destructive examination surveys, two life-cycle cost studies and three cogeneration feasibility studies. Most clients are planning to implement FIBP's recommendations, and all clients have contracted the FIBP to assess their other heating plants.

Buildings Energy Technology Advancement Plan

The Buildings Energy Technology Advancement (BETA) Plan is an integrated set of programs dedicated to developing energy-efficient technologies for residential and commercial buildings in Canada. Through the BETA Plan, CANMET brings together governments, industry and universities to develop a new generation of buildings technology that would reduce the energy consumption of Canadian buildings by 50 per cent. The plan addresses new, reconstructed and renovated building stock.

■ BETA Plan — Residential

Purpose

To assist in the development and commercialization of energy-efficient technologies for residential buildings.

Activities

The BETA Plan for residential buildings includes technology development, technology transfer and quality assurance for the advancement of

Canadians have found it difficult to obtain understandable, verified information on the energy performance of windows.

energy-efficient and environmentally responsible housing technologies. BETA works in collaboration with industry to act on technology developments to improve industry's competitive position and reduce CO₂ emissions. The plan emphasizes pre-market technologies that can be deployed in new buildings or in retrofit projects, including residential space- and water-heating systems, and lighting, cooling and ventilation equipment. BETA shares costs with private sector companies, utilities, trade associations, universities and provincial governments. Through BETA, these organizations leverage substantial amounts of federal funds.

Projects include R&D and field trials of emerging technologies, the development of design tools, technology transfer initiatives and technical advice to other residential building initiatives (such as the R-2000 Home Program) and utility DSM programs. The BETA Plan encompasses two programs that focus directly on residential buildings. The first, the Advanced Houses Program, features the construction, public demonstration and performance monitoring of 10 houses across Canada that use one quarter of the energy of conventional homes (or one half the energy of R-2000 homes). The second, the Building Systems and Indoor Environment Program, supports the development of ventilation and indoor air quality standards, as well as advanced building design tools, and heating, ventilation and air conditioning equipment.

Achievements in 1992-93

- Opened the Manitoba Advanced House and the Saskatchewan Advanced House. Another eight advanced houses were at various stages of completion across Canada. The projects have attracted considerable attention from the domestic and international building industries, the public and the media.

- The Advanced Houses were featured at the annual conference of the Canadian Home Builders' Association, which was attended by more than 500 industrial delegates. One session dealt with technology advances achieved under the program.

- Named GE Canada and Camco as official suppliers to the Advanced Houses Program for energy-efficient lights, motors, meters, silicones, distribution panels and appliances.

- Released a new version of the HOT2000 Energy Simulation Program, one of the most widely used energy analysis tools for houses. The computer program will be used with the R-2000 Home Program as well as the 'performance path' of the 1995 *National Energy Code for Buildings*. The software is also used by utilities and builders throughout North America.

- The International Energy Agency (IEA) group on photovoltaics for buildings selected Ottawa's Advanced House, the Innova House, as Canada's contribution to the IEA photovoltaics in building projects. Featuring a photovoltaic system connected to the electric utility grid, the system was co-funded by Ontario Hydro and Energy Diversification Research Laboratory (EDRL) of CANMET.

■ BETA Plan — Commercial

Purpose

To support the commercial building industry's efforts to develop, commercialize and adopt energy-efficient and environmentally responsible technologies.

Activities

The BETA Plan for commercial buildings includes technology development, technology transfer and quality assurance

*The International
Energy Agency (IEA)
selected Ottawa's
Advanced House, the
Innova House, as
Canada's contribution
to the IEA photovoltaics
in building projects.*

initiatives that are designed to assist the commercial buildings sector to improve its energy and environmental performance. Program activities are geared to addressing the technology and information gaps that inhibit the adoption of energy-efficient technologies in this sector. BETA conducts projects in close cooperation with the building industry, other federal departments and provincial governments and utilities and shares costs with these organizations. The BETA Plan encompasses three components targeted to the commercial buildings sector:

- the C-2000 Advanced Commercial Buildings Program;
- building systems and indoor environment activities; and
- technical support services.

The C-2000 Program accelerates the adoption of emerging technologies by demonstrating that commercial buildings can be more energy-efficient, have better indoor environments and reduce impacts on the environment. A wide range of energy and building industry stakeholders are jointly funding a limited number of advanced energy-efficient commercial buildings being constructed across Canada. These will demonstrate how to achieve environmental objectives, such as curbing CO₂ emissions and adopting CFC-free technologies.

Building systems and indoor environment activities focus on the analysis and assessment of innovative cooling techniques, ventilation equipment, lighting, office equipment and building assemblies, as well as the development of energy simulation tools.

Technical support is provided for the application of advanced technologies in other federal, provincial or utility-led programs affecting commercial buildings.

Achievements in 1992-93

- Began drafting technical requirements for the pilot phase of the C-2000 Program, with the assistance of Canada Mortgage and Housing Corporation (CMHC), Ontario Hydro and the Ontario Ministry of Energy and Environment. These technical requirements include mandatory and suggested guidelines for the design, construction, commissioning, operation and maintenance of a C-2000 building. These requirements pertain to energy and environmental performance.
- Signed a licensing agreement with the National Research Council and W.H. Kemp and Associates to commercialize the SmartBar, an energy-saving power bar for computers and related equipment.
- Reached a two-year technology transfer agreement with the Royal Architectural Institute of Canada to support the publication of a bimonthly newsletter, *Advanced Buildings*, on large-building R&D activities. The newsletter is financed by the Panel on Energy Research and Development and subscriptions in Canada and the United States.
- Initiated the Energy Simulation Users' Group to coordinate software development. The group comprises NRCan, Hydro-Québec, Ontario Hydro, Manitoba Hydro, Canadian Electrical Association, National Research Council, Ministère de l'Énergie et des ressources (Québec) and Public Works and Government Services Canada.
- Began a study with Tim Donut Limited (Tim Horton), a fast food chain, to monitor building performance and recommend improvements. This is expected to lead to a pilot energy-efficiency project.

*A wide range of energy
and building industry
stakeholders are jointly
funding advanced
energy-efficient
commercial buildings
across Canada.*

■ **BETA Plan — Passive Solar**

Purpose

To develop, commercialize and encourage the adoption of high-performance window technologies for residential and commercial buildings.

Activities

This component of the BETA Plan includes technology and product standards development, technology assessments, technology transfer and quality assurance for four categories:

- high-performance and advanced window R&D;
- industry support;
- daylight and commercial building applications; and
- system integration and passive solar modelling.

Costs are shared with industry (mostly small- to medium-sized enterprises) and other organizations, including universities, trade associations, research councils, utilities and other levels of government. Overall, federal funds have been matched by program participants.

A major thrust of the plan is to develop a window labelling program, and product and installation standards. The aim is to assist the industry in developing high-performance window products for the residential retrofit market. The plan also supports the development of super high-performance windows that enhance the market's best designs, and for ultra-advanced windows, based on emerging technologies such as electrochromics or aerogels. Other areas of activity include the development

of computer simulation and design software, and window durability test methods.

Achievements in 1992-93

- Developed a new Canadian Standards Association (CSA) standard to determine window energy performance, based on CANMET research and computer simulation programs. This standard is the only one in the world that accounts for both heat losses and solar gains. More than 1 000 Canadian window products have been evaluated using this standard.
- Supported the Canadian Window and Door Manufacturers Association in the establishment of a window certification, energy rating and labelling program. This program will provide consumers with access to high-quality products with superior energy efficiency.
- Released VISION 3.0 and FRAME 3.0 window energy simulation programs. The latter, developed for CANMET by Enermodal Engineering, Ltd., received a Canada Award for Business Excellence. Manufacturers and researchers worldwide are using the programs, with performance predictions accepted as a basis for compliance with international standards.
- Developed a unique procedure to measure window solar heat gain at the National Solar Test Facility. This method satisfies testing requirements for the CSA.
- Carried out extensive technology transfer through, for example, workshops for industry on the CSA energy performance standards and through seminars, fact sheets, articles and presentations at home shows to inform the public.

A window labelling program aims to assist the industry in developing high-performance window products for the residential retrofit market.

Heat Management Program

Purpose

To help Canadian companies, manufacturers and energy users develop, commercialize or acquire advanced heat management technologies.

Activities

The Heat Management Program is operated by the Energy Diversification Research Laboratory (EDRL) of CANMET. It develops and promotes the application of advanced heat management technologies. These include:

- advanced heat pumps;
- heat storage;
- heat exchangers;
- energy management control systems;
- modelling and simulation of equipment and processes; and
- optimization of equipment, systems and process applications.

The program operates in a variety of ways, including applied R&D on specific technologies; participation in cost- and task-shared R&D projects with industry, universities, research organizations or government departments; and the provision of laboratory and technical services on a cost-recovery basis.

The Heat Management Program has adopted a three-element strategy based on the needs of its clients for advanced technologies. The first element is to work closely with Canadian heating, air conditioning and refrigeration equipment manufacturers to help them identify gaps in technology and develop competitive energy-efficient technologies. The second element is an effort to transfer technology to the

consulting engineering community to raise its awareness of the advanced technologies now entering the marketplace. The third element is to encourage the deployment of advanced technologies to end users in the commercial and industrial sectors, through targeted R&D, technology transfer and the forging of links with the suppliers of technology.

Achievements in 1992-93

- Took occupancy of new laboratory facilities in Varennes, Quebec. The 2 700 square-metre laboratory is located in a high-technology scientific park with one of the highest concentrations of energy research in Canada.
- Launched a \$2 million, five-year research agreement with Gas Technology Canada, an R&D consortium made up of La Société en commodité, Gaz Métropolitain, The Consumers Gas Company Ltd., Union Gas Limited and British Gas Holdings (Canada) Ltd., to develop and transfer a gas-fired absorption heat pump technology. The heat pump, to be used for heating and cooling, will be a durable alternative to CFC-based technology and has considerable market potential. It should be ready for demonstration by 1997.
- Sponsored a Thermochemical Technologies Workshop on October 15, 1992. The event attracted nearly 50 representatives from the heating, ventilating, air conditioning and refrigeration industry, as well as other client groups such as the food industry. The workshop helped raise awareness among manufacturers and consultants about thermochemical heat pumps and showcased the state of the art in this technology. Three working groups tackled specific problems related to new technology. These results were compiled and disseminated in the workshop proceedings.

A gas-fired absorption heat pump will be a durable alternative to CFC-based technology and has considerable market potential.

Equipment Energy Use

The energy efficiency of a building can be enhanced by improving building design and construction (e.g., insulation levels and airtightness), the efficiency of the equipment used within (e.g., furnaces and air conditioners) and the energy practices of the occupants (how they operate and maintain equipment). This chapter focuses on energy-using equipment.

Examples of energy-using equipment are:

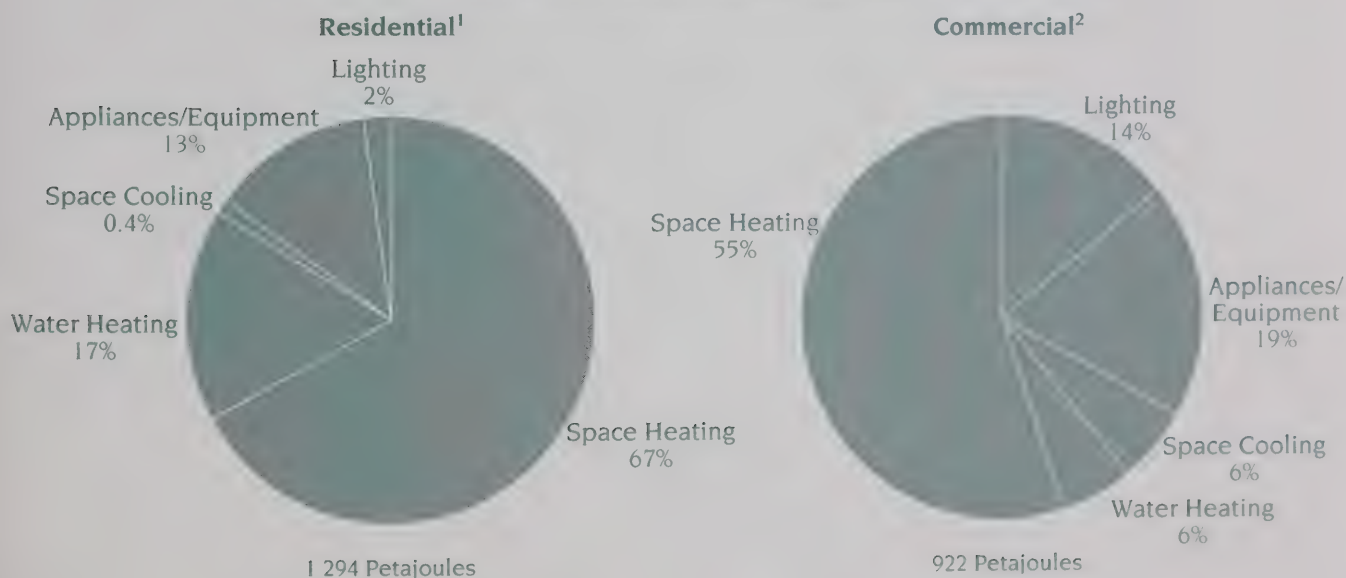
- household appliances (the six major ones are refrigerators, freezers, dishwashers, ranges, clothes washers and clothes dryers);

- water heaters;
- lighting fixtures (including lamps and ballasts);
- equipment for space heating and cooling;
- commercial refrigeration units, such as those used in supermarkets; and
- motors, such as those used in the industrial sector.

Figure 5.1 provides a breakdown, by equipment category, of energy use in the residential and commercial sectors. Space heating accounts for the largest share of energy use in both sectors (about 67 per cent in the residential

Figure 5.1

Residential and Commercial Energy Use by End Use – 1992



1 – Excludes farm motive use.

2 – Excludes aviation fuels, diesel fuel oil and motor gasoline.

Sources: Statistics Canada, "Quarterly Report on Energy Supply – Demand in Canada," Cat. No. 57-003, 1992-IV.

Natural Resources Canada, Residential End Use Model.

Natural Resources Canada, Commercial End Use Model.

sector and about 55 per cent in the commercial sector).

In the residential sector, water heating accounts for the second largest share (17 per cent) of energy use, followed by appliances (13 per cent). Space cooling and lighting account for only a tiny portion of residential energy use.

In the commercial sector, appliances (19 per cent) and lighting (14 per cent) are the second- and third-largest energy end uses. Water heating and space cooling together account for only 12 per cent of commercial energy use.

Developments in Energy Efficiency

From 1978 to 1992, residential energy use increased by 9 per cent. This increase can be explained by a number of factors, including the number of households, house size, and new energy-using equipment, such as videocassette recorders and home computers. However, residential sector energy intensity, which is defined as the amount of energy used per household, decreased by 20 per cent from 1978 to 1992. This decrease in energy intensity can be attributed to improvements in energy efficiency.

Since the late 1970s, the federal government has promoted more efficient use of energy-using equipment and the use of more energy-efficient equipment by publishing consumer literature and administering the EnerGuide Program. EnerGuide is a labelling program designed to help consumers choose the most energy-efficient household appliances.

Recent activities promoting greater energy efficiency in equipment include provincial minimum energy-efficiency standards for energy-using appliances and equipment, and utility incentive programs (e.g., rebates for purchasing high-efficiency refrigerators).

In Canada, significant energy-efficiency gains have been achieved for the six major appliances since the 1970s. Figure 5.2 compares average energy-use ratings for typical appliances (in kilowatt-hours annually) for the years 1978 and 1993, as well as the most efficient ratings for 1993.

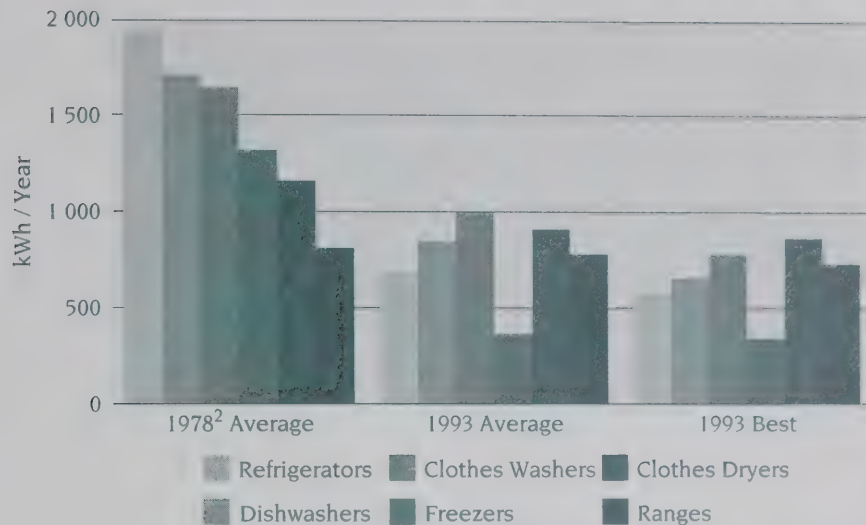
Most of the gains achieved in household appliances have come from a few simple changes. The evolution of energy efficiency in refrigerator technology is a good example. Improved insulation in refrigerators has significantly reduced heat gain through the shell. As well, most new refrigerators use a compressor that is considerably more efficient than that used in older units.

Before the 1980s, users of natural gas for residential space heating had only the conventional class of heating equipment, with annual fuel-utilization efficiencies of 65 per cent or less. Since that time, more energy-efficient models have become widely available. Mid-efficiency units, which now represent the largest proportion of natural gas furnaces sold, achieve efficiencies of approximately 80 per cent, and high-efficiency units realize efficiencies of 90 per cent or greater.

Over the past 15 years commercial sector energy intensity, which is defined as the amount of energy used per unit of floor space area, has continued to improve. This is especially true in office and retail buildings, which are the largest commercial energy users accounting for 39 per cent of total energy use in 1992. Energy intensity for office buildings decreased by 15 per cent between 1980 and 1985, and further improvements have been made through increased market penetration of new, more energy-efficient technologies such as lighting, motors and heating. Provincial activities, including minimum energy-efficiency standards for energy-using equipment, are directed at improving energy efficiency in the commercial sector, as in the residential sector.

*EnerGuide is a
labelling program
designed to help
consumers choose the
most energy-efficient
household appliances.*

Figure 5.2
Trends in Appliance Energy Use¹ in Canada, 1978 and 1993



1 – Based on typical appliances in terms of size and features. Figures for dishwashers and clothes washers include the energy required to heat the water.

2 – Averages for 1978 would be marginally less if products were tested using the same procedures as those for 1993.

Sources: Marbek Resource Consultants Ltd., Appliance Efficiency Information Base. May 1987
Natural Resources Canada, EnerGuide Program.

In Canada, significant energy-efficiency gains have been achieved for the six major appliances since the 1970s.

Improvements in commercial sector energy intensity, however, have been slowed by the rapid growth in the use of electronic equipment, such as facsimile machines, computers and photocopiers. Furthermore, increasing use of air conditioners has resulted in an increase in electric energy use.

Efficiency Standards for Equipment

Purpose

To eliminate inefficient equipment from the Canadian market by establishing national energy-efficiency standards for equipment.

Activities

Regulations under the *Energy Efficiency Act* prohibit imports or interprovincial trade in energy-using products that do not meet a prescribed minimum level of energy efficiency. The products and minimum levels are specified after

energy and economic analysis and consultation with stakeholders. The major stakeholders are the provincial and territorial governments, manufacturers of energy-using equipment, electric utilities and public interest groups. The choice of products and levels is based on consideration of five factors:

1. maximum energy savings and reductions in CO₂ emissions;
2. the economic attractiveness of more energy-efficient models of a product;
3. the impact on Canadian manufacturers;
4. harmonization with standards set by other regulating agencies — primarily the provinces, territories and United States; and
5. operational matters such as consensus on testing approaches, availability of laboratory and certification facilities, and national distribution of production.

For any specified product, the minimum level of energy efficiency and the testing procedure are set out in the regulations. NRCan helps develop such standards by funding and participating in standards-writing committees under the auspices of the CSA and the Canadian Gas Association. A major part of the program is monitoring the industry and enforcing the regulations. This is undertaken through agreements with third-party certification agencies accredited by the Standards Council of Canada. To detect non-compliance, NRCan will implement a monitoring program with the provinces' utilities and the Department of National Revenue (Customs and Excise).

Achievements in 1992-93

- Issued two discussion papers seeking stakeholder comment on:
 - the policy direction of the regulatory program ("Regulation of Energy Efficiency and Labelling of Equipment in Canada") and
 - the design of the program ("The Equipment Regulation and Labelling Program – How We'd Like It to Work").
- Drafted the first regulations under the *Energy Efficiency Act*, setting minimum efficiency standards for 20 products regulated in one or more of the provinces.
- Funded the development of a number of efficiency standards, including a joint CSA – Air Conditioning and Refrigeration Institute standard for packaged terminal air conditioners, and CSA standards for ground source heat pumps, split system and central air conditioners and heat pumps, and dehumidifiers.
- Designed a state-of-the-art compliance program. The preregulatory compliance activity will establish benchmarks for assessing compliance rates.

- Worked with provincial governments and utilities to ensure a coordinated approach to developing national standards, and with foreign agencies (e.g., the U.S. Department of Energy) to harmonize testing standards and efficiency levels.

EnerGuide

Purpose

To encourage consumers to purchase energy-efficient equipment by providing them with information on the product's energy efficiency.

Activities

The products requiring the EnerGuide label must follow federal regulations. They are selected in consultation with stakeholders. Marketplace monitoring and enforcement systems are implemented by conducting marketplace audits on the frequency of labelling.

Comprehensive information and education campaigns are being developed to foster consumer understanding of the EnerGuide label and the benefits of energy efficiency. These campaigns involve the preparation and distribution of publications, the use of print media and an exhibits program. In collaboration with its strategic allies, NRCan develops training programs for retail salespeople, which teach them how to use the EnerGuide label. These programs have been implemented by major electric utilities and manufacturers.

Achievements in 1992-93

- Conducted market research to establish EnerGuide label recognition and design. Based on that research, a new label was designed. The EnerGuide Steering Committee, an advisory group of representatives from manufacturers, manufacturing associations, retailers, consumer groups, electrical

Comprehensive information and education campaigns are being developed to foster consumer understanding of the EnerGuide label and the benefits of energy efficiency.

utilities and environmental groups, contributed to the design of the label.

- Drafted regulations under the *Energy Efficiency Act* that provide the specifications of the label and the products that display it.
- Conducted studies to determine the level of compliance in the use of the EnerGuide label under previous

regulations and designed a comprehensive compliance strategy to support the new regulations.

- Designed brochures, course material and posters for a retailer training program.
- Recruited utility allies, such as trade associations, which will incorporate EnerGuide into their DSM programs.

Industrial Energy Use

The Canadian industrial sector includes manufacturing, mining and forestry activities. Industrial energy use is composed of the energy required by the process-specific technologies within each industry, such as a pulp refiner, a cement kiln or a blast furnace, and all energy needed for service of auxiliary devices. Such applications include steam generation and pumping or compression. Other industrial uses include lighting, heating, ventilation and air conditioning. In 1992 industrial energy use amounted to 2 384 PJ or 35 per cent of Canada's total secondary energy use.

The industrial sector has a fairly high concentration of energy use in a few industries, as shown in Table 6.1. Pulp and paper, mining, and iron and steel together account for more than one half of industrial energy use.

Figure 6.1 shows the secondary energy use by energy type in the largest energy-consuming industries. The three major energy sources used by industry are electricity, natural gas and refined petroleum products. The pulp and paper industry also consumes large amounts of hog fuel¹ and spent pulping liquor,² while the iron and steel industry is a significant consumer of coking coal and

Pulp and paper,
mining, and iron and
steel together account
for more than one half
of industrial energy
use.

¹ Hog fuel consists of pulverized bark, shavings, sawdust and low-grade lumber rejects from the operation of pulp mills, saw mills and plywood mills.

² Spent pulping liquor is a substance primarily made up of lignin, other wood constituents and chemicals that are by-products of the manufacture of chemical pulp. It can be used in a boiler to produce steam or electricity.

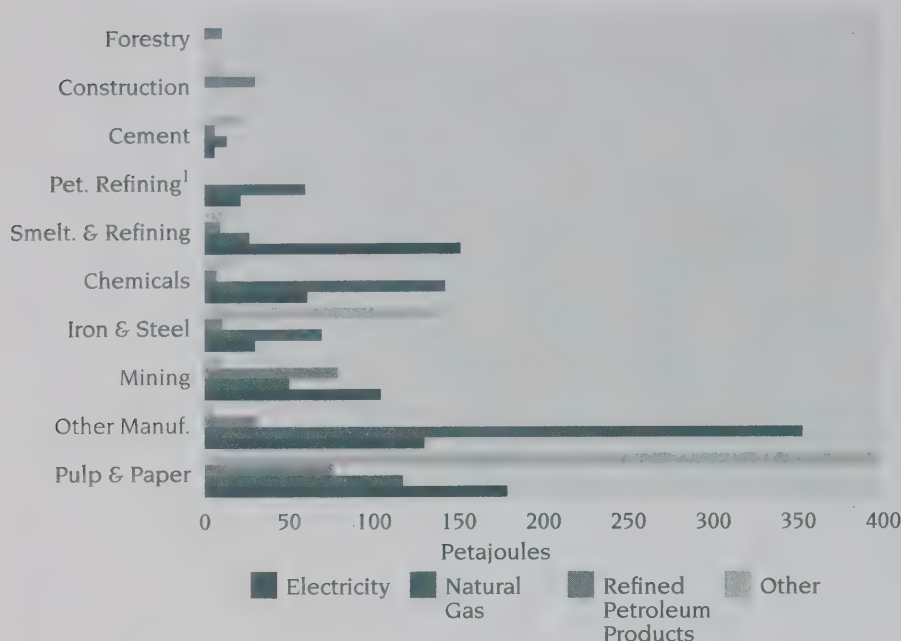
Table 6.1
Industrial Energy Use by Sector - 1992

Industry	Petajoules	Per cent
Pulp and paper	770	32
Iron and steel mining	247	10
Mining	244	10
Chemicals	225	10
Smelting and refining	201	8
Petroleum refining ¹	81	3
Cement	47	2
Construction	39	2
Forestry	10	1
Other manufacturing	520	22
TOTAL	2 384	100

¹ In accordance with Statistics Canada's definition of the industrial sector, producer's consumption of non-purchased petroleum products is not reported as industrial sector final demand. Including this consumption would result in petroleum refining energy consumption of approximately 320 petajoules.

Source: Statistics Canada, *Quarterly Report on Energy Supply - Demand in Canada*, Cat. No. 57-003, 1992-IV.

Figure 6.1
Industrial Secondary Energy Use by Fuel Type - 1992



¹ - In accordance with Statistics Canada's definition of the industrial sector, producer's consumption of non-purchased petroleum products is not reported as industrial sector final demand. Including this consumption would result in petroleum refining energy consumption of approximately 320 PJ.

Source: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.

coke oven gas. Table 6.2 indicates how energy's importance varies significantly from industry to industry.

Figure 6.2 ranks the major energy-consuming industries by energy intensity (i.e., energy use per dollar of output). The figure shows that the largest energy users are not necessarily the most energy-intensive users.

Developments in Energy Efficiency

Figure 6.3 shows that according to the Canadian Industry Program for Energy Conservation (CIPEC),¹ energy intensity in the industrial sector declined by 26 per cent (or 1.5 per cent annually) over the last two decades. The measures contributing to improvements in energy intensity include avoiding the use of oversized equipment and installing more efficient motors, variable-speed

drives and heat-recovery technologies; improving process controls and energy monitoring; and implementing new, more efficient processes.

Industrial Energy Efficiency

Purpose

To increase the efficiency of energy use in goods-producing industries.

Activities

This initiative is predicated on a voluntary, industry-driven approach to foster industrial energy efficiency and to contribute to emission limitation and economic competitiveness. It includes three interrelated elements:

- a Minister's Advisory Council on Industrial Energy Efficiency (MACIEE);

Measures contributing to improvements in energy intensity include avoiding the use of oversized equipment, installing more efficient motors and implementing new more efficient processes

¹ CIPEC is a voluntary industry-driven program responding to both competitiveness and GHG emission goals. CIPEC was originally created in 1975 in response to energy prices and security of supply issues.

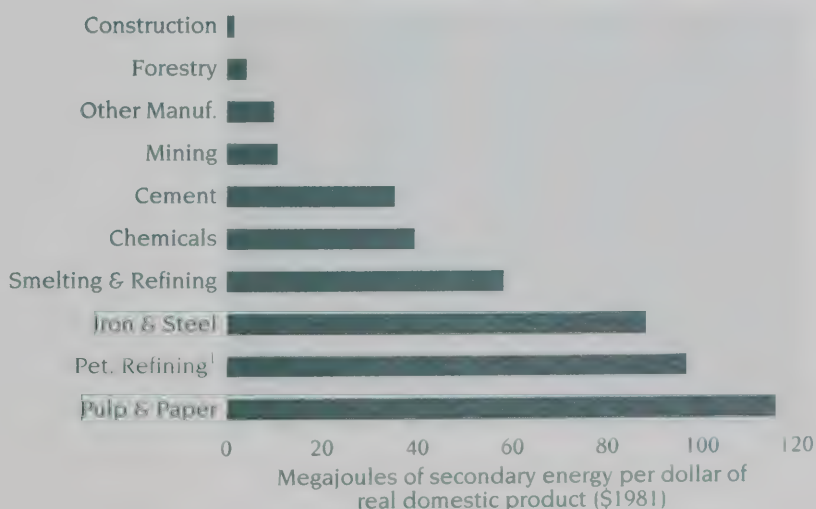
Industrial energy use is composed of the energy required by the process-specific technologies within each industry, such as a pulp refiner, a cement kiln or a blast furnace, and all energy needed for service of auxiliary devices.

Table 6.2
The Importance of Energy Purchases in Selected Industries - 1991

Industry	ENERGY PURCHASES AS A SHARE OF:	
	Total production costs (per cent)	Value of shipments (per cent)
Cement	36.0	16.3
Chemicals	14.0	9.2
Smelting and refining	13.8	10.1
Pulp and paper	12.0	9.8
Iron and steel	9.3	7.6
Petroleum refining	2.0	1.9
Other manufacturing	2.2	1.6

Source: Statistics Canada, "Manufacturing Industries of Canada: National and Provincial Areas, 1991," Cat. No. 31-203.

Figure 6.2
Industrial Energy Intensity by Sector - 1992

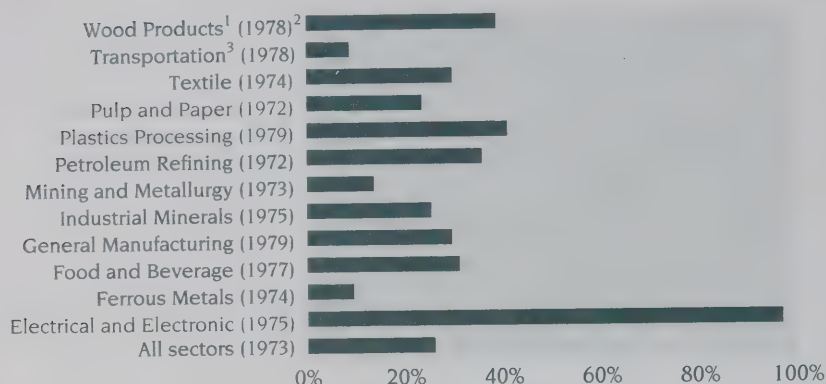


1 - In accordance with Statistics Canada's definition of the industrial sector, producer's consumption of non-purchased petroleum products is not reported as industrial sector final demand. Including this consumption would result in an energy intensity of approximately 380 megajoules per dollar

Source: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.

NRCan, "Canada's Energy Outlook," 1992-2020, Sept. 1993.

Figure 6.3
Industrial Sector Energy Intensity Improvements
through 1990



1 – Represents the British Columbia forest industries.

2 – Figures in parentheses indicate base year from which improvements are calculated.

3 – Transportation equipment manufacturing.

Source: Canadian Industry Program for Energy Conservation. Annual Report 1990.

- a revitalization of CIPEC, which was first established in 1975; and
- an Industrial Energy Innovators Program.

The MACIEE provides a forum for an executive-level discussion of energy-efficiency policy, planning and project implementation within the industrial sector. The MACIEE meets annually to review progress and to look at opportunities for industry to contribute to Canada's GHG limitation process.

CIPEC consists of an Industry Policy Board, an Industry Council, sectoral task forces and a secretariat. Within the Policy Board, chief executive officers provide an industry-wide consensus on initiatives and contribute to the overall direction of the MACIEE. The Industry Council is made up of the chairpersons of the sectoral task forces, who coordinate and direct the activities of the task forces and liaise with the Policy Board on policy direction and priorities.

The sectoral task forces establish energy-efficiency targets and strategies for their achievement. They also identify sectoral and company-level opportunities for project implementation.

The Industrial Energy Innovators Program recruits and encourages industrial energy users to develop long-term energy management planning and replication strategies for their companies.

Achievements in 1992-93

- Established the CIPEC secretariat.
- Developed a 1990 baseline for energy use in the principal goods-producing sectors, which will permit the establishment of realistic targets for emissions reduction.
- Established industrial sector task forces and recruited members.
- Initiated studies on sector energy-efficiency potential and end use.

The Minister's Advisory Council on Industrial Energy Efficiency provides a forum for an executive-level discussion of energy-efficiency policy, planning and project implementation within the industrial sector.

Canadian Energy Management and Environmental Training Program

Purpose

To provide industrial and commercial energy users with access to energy efficiency and energy-related environmental training opportunities.

Activities

Canadian Energy Management and Environmental Training (CEMET) Program meets energy management training needs through strategic alliances in the industrial, commercial, educational, governmental and institutional sectors. CEMET identifies client's training needs within the industrial and buildings sectors, develops training and retraining materials (in cooperation with stakeholders) and delivers cost-effective training programs. CEMET fulfils its purpose through Canada's network of community colleges and CEGEPs by providing access to energy management training, needs analysis services, competency-based evaluation, training materials, course design and delivery, and evaluation. The program also provides lead funding for an executive office to operate the program. Energy management training provided by this initiative is critical to the activities of the Federal Buildings Initiative, the Energy Innovators Initiative and the Industrial Energy Efficiency Initiative.

Achievements in 1992-93

- Signed a contract with the Canadian Gas Association to develop five CEMET training modules.
- Signed a three-year contribution agreement with Durham College (in Oshawa, Ontario) to establish the CEMET directorate, which provides a permanent link between industry,

utilities, governments and colleges to address energy management training needs. The directorate provides energy users with the following services: sectoral and client-specific needs assessment; curriculum resources and development services; national training delivery network; client evaluation and follow-up; and energy measurement competency profiles.

- Delivered three pilot courses on boiler plant systems, steam and condensate systems, and furnaces, dryers and kilns to 110 students in seven community colleges across Canada.
- Co-sponsored a series of five energy management workshops organized by the Canadian Association of Petroleum Producers in Alberta.
- Gained acceptance and recognition from the oil industry for its role in promoting energy management training and retraining in cooperation with community colleges.

Industry Energy R&D

Purpose

To assist industry in the development and application of more energy-efficient technologies.

Activities

CANMET's Industry Energy R&D (IERD) Program supports the development and application of leading-edge energy-efficient processes, products, systems and equipment in all industrial sectors. The cost of technology development is shared with industry and others. While IERD's contribution averages about 35 per cent, it can be as high as 50 per cent depending on technical risk, the potential for energy savings, and the degree to which the technology could improve Canada's economic competitiveness.

CEMET identifies client's training needs within the industrial and buildings sectors and delivers cost-effective training programs.

The Advisory IERD Board, made up of Industry Canada, Environment Canada and Transport Canada representatives, reviews and recommends projects. Program clients range from innovative small- to medium-sized R&D companies to multinationals. To encourage the widest possible application of the technologies developed, the program:

- strives to link technology developers and end users;
- encourages the formation of research consortia; and
- supports technology transfer.

Achievements in 1992-93

- Approved a new agreement with Stackpole Limited to expand its product line to high-performance automotive components. The company invested \$30 million in a new plant in Mississauga and increased employment by more than 200 people.
- Supported the Council of Forest Industries of British Columbia in the development of a radio-frequency — vacuum kiln to dry softwood lumber faster and more efficiently, and to eradicate pinewood parasites. Removal of these parasites delayed a European Community ban on Canadian lumber exports.
- Supported Norvik Traction Inc. of Mississauga in the development of an innovative multipurpose fast battery charger that has a large potential market in the transportation, industrial and mining sectors.

Industrial Targeted R&D

Purpose

To identify and foster opportunities for energy-efficiency R&D, field trials and technology transfer in the goods-producing industries.

Activities

This initiative provides leadership and coordination among interested companies and other stakeholders. It identifies technical barriers to Canadian companies becoming more energy-efficient and supports the implementation of innovative technological solutions that contribute to a cleaner environment, improved productivity and product quality, reduced waste and a stronger market position for Canadian companies. The program targets industrial sector technologies offering the highest rate of return.

The program first identifies the R&D opportunities in specific sectors and then conducts technology assessments of these opportunities, including descriptions of technologies, potential energy benefits, state of development, environmental impacts, potential market penetration and the economics of implementation. Technology development projects have been launched in cooperation with industry, particularly the pulp and paper, iron and steel, cement, and chemical sectors. Activities are developed, managed and funded (usually shared equally with industry) in cooperation with the gas and electric utilities, other governments and equipment manufacturers.

Achievements in 1992-93

- Issued a report identifying 50 technological opportunities to improve energy efficiency in the pulp and paper sector and initiated the development of an action plan to follow up on the most appropriate new technologies.
- Issued a report on the energy-efficiency opportunities in the secondary aluminum recycling industry, which identified seven major areas for longer-term R&D activities.
- Completed a cement and concrete sector study that identified opportunities for the increased use of waste

Technology

development projects have been launched in cooperation with industry, particularly the pulp and paper, iron and steel, cement, and chemical sectors.

materials and replacement of some of the cement used in the production of the concrete. Based on the study, field trials were developed in these two areas.

- Initiated sector studies for iron and steel, food and beverage, mining and metallurgy, and oil and gas.
- Launched technical assessments for chemical pulp bleaching, industrial refrigeration, grain drying, meat packing and high-temperature heat pumps.

Gas Technologies Program

Purpose

To develop advanced natural gas technologies for the commercial and industrial sectors.

Activities

CANMET's EDRL Gas Technologies Program supports the development of a new generation of energy-efficient natural gas technologies, which could open a number of international market niches. This program emphasizes the development of advanced technologies for gas storage, gas-fired environmental technologies and gas-fired industrial processes. Support for technology development and deployment includes in-house applied R&D on specific technologies, participation in cost- and task-shared R&D projects with industry,

universities, research associations or other government departments and the provision of laboratory and technical services on a cost-recovery basis.

Program clients include gas utilities, small- to medium-sized gas equipment manufacturers and large-scale natural gas users. The laboratory strives to create strategic alliances among these three groups especially multiple-ally research consortia. These alliances assist in identifying and launching R&D projects that respond to technology gaps and opportunities. The laboratory also assists, through R&D support and cost-sharing, the efforts of independent technology innovators to develop and commercialize technologies for specific market niches.

Achievements in 1992-93

- Launched a project to develop a low-pressure system for natural gas storage and related compressor costs, with the support and participation of Gaz Métropolitain Inc.
- Initiated a project to develop improved systems for the catalytic combustion of natural gas, with the support of British Gas Holdings (Canada) Ltd.
- Initiated a project to develop a less expensive material to catalyze chemical reactions within fuel cells to produce electricity, with the participation of Hydro-Québec and l'Institut national de la recherche scientifique.

Strategic alliances assist in identifying and launching R&D projects that respond to technology gaps and opportunities.

Transportation Energy Use

Transportation energy is energy used in road, air, marine and rail transportation. In 1992 the transportation sector used about 27 per cent of total secondary energy or 1 809 PJ. Within the transportation sector, road transportation accounts for about 80 per cent of energy use (1 443 PJ) with the remaining demand coming, in descending order, from air, marine and rail transportation. As shown in Figure 7.1, gasoline accounts for about 77 per cent and diesel fuel for 21 per cent of total energy use in the road segment, while alternative fuels, such as propane and compressed natural gas, account for the remaining two per cent.

Gasoline consumption in the road segment is almost exclusively attributable to cars and light trucks. However, heavy trucks account for most road diesel use.

29 per cent and medium and heavy trucks use some five per cent (see Figure 7.2). However, heavy trucks account for most road diesel use. Light-duty vehicles continue to be very small consumers of road diesel, representing only a small percentage of energy use.

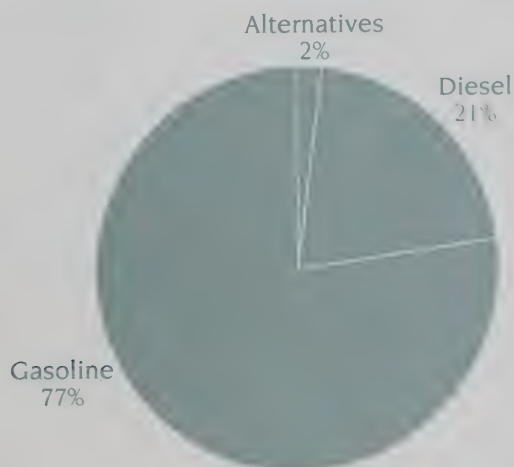
Developments in Energy Efficiency

Canada's light-duty vehicle fleet stock is made up of about 15.1 million units of which 73 per cent are cars and 27 per cent are light trucks (less than 3 864 kg).

Company average fuel consumption (CAFC) targets have been in effect in Canada since 1978. Compliance with these targets by vehicle manufacturers is voluntary.

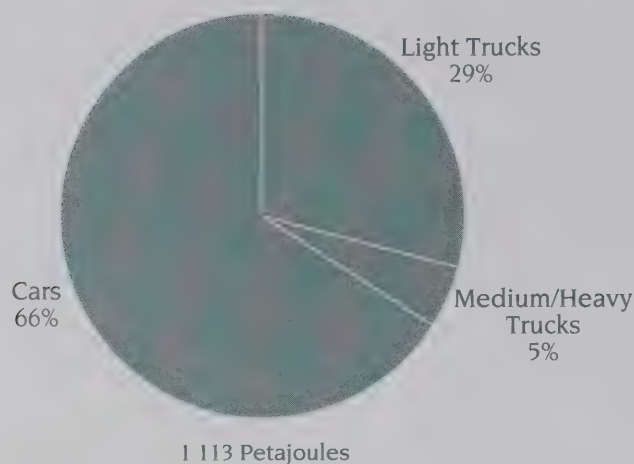
Figure 7.3 shows that, on average, motor vehicle manufacturers have met or exceeded the program targets for cars

Figure 7.1
Road Segment Energy Demand by Fuel - 1992



Sources: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.
Natural Resources Canada, Transportation Energy Demand Model.

Figure 7.2
Road Segment Motor Gasoline Demand by Vehicle Type - 1992



Sources: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.
 Natural Resources Canada, Transportation Energy Demand Model.

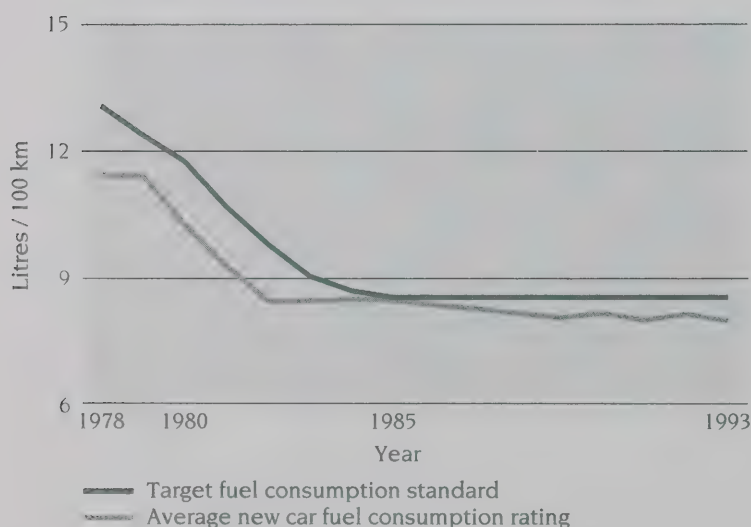
in every model year. According to CAFC ratings, new cars sold in Canada in 1993 averaged 8.0 L/100 km, which exceeded the target level of 8.6 L/100 km. Although not represented in Figure 7.3, the light-truck program targets, which took effect for the 1990 model year, have also been met for each model year.

The CAFC ratings of new light trucks sold in Canada in 1993 averaged 11.3 L/100 km, marginally better than the target level of 11.5 L/100 km.

Manufacturers have improved the fuel consumption of new cars primarily by reducing vehicle weight and friction, and by improving engines and aerodynamics

New cars sold in Canada in 1993 averaged 8.0 L/100 km, which exceeded the target level.

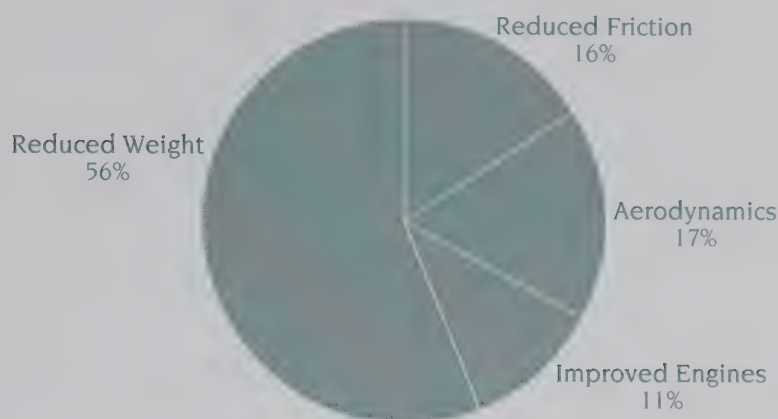
Figure 7.3
New Car Fuel Consumption Ratings and Target Standards in Canada, 1978 - 1993¹



¹ - Based on laboratory tested values.

Source: Road Safety Directorate, Transport Canada.

Figure 7.4
Main Factors in Improved Automotive
Fuel Consumption Ratings, 1978 - 1987



Source: Efficiency and Alternative Energy Branch,
 Natural Resources Canada.

*As with cars,
 manufacturers have
 been able to meet the
 light-truck CAFC
 targets.*

(see Figure 7.4). Although the efficiency improvements have been significant, the greatest gains occurred between 1978 and 1982, when world oil prices were at an all-time high and the CAFC target was lowered from 13.1 L/100 km to 9.8 L/100 km. Since 1984, world oil prices have fallen, the CAFC targets have remained virtually unchanged and vehicle fuel-efficiency improvements have been marginal.

Annual light-truck sales have been growing as a percentage of new light-duty vehicle sales, from about 20 per cent in 1982 to 33 per cent in 1992. The extension of fuel consumption standards to light trucks in 1987 reflected the growing proportion of these vehicles in the light-duty vehicle fleet and also emphasized the fuel consumption characteristics of an increasingly important type of vehicle. The first standards, which took effect for the 1990 model year, set the light-truck CAFC goal at 11.8 L/100 km. The goal has since been made more stringent (11.5 L/100 km for the 1993 model). As with cars, manufacturers have been able to meet the light-truck CAFC targets. More efficient engines and other technological improvements have allowed manufacturers to change vehicle characteristics

to meet consumer demand and have resulted in an average light-truck weight increase of almost 11 per cent without increasing fuel consumption.

Motor Vehicle Fuel Consumption Standards

Purpose

To ensure that new motor vehicles meet or exceed average fuel-efficiency standards.

Activities

The federal government currently administers the Motor Vehicle Fuel Consumption Standards (MVFCS) Program and publishes and distributes the *Fuel Consumption Guide*. The program sets fuel-efficiency targets for new vehicles to encourage motor-vehicle manufacturers to produce and sell more fuel-efficient cars and light trucks. As well, manufacturers are requested to affix fuel consumption labels to new vehicles offered for sale. The *Fuel Consumption Guide* complements these activities by offering potential vehicle buyers fuel-efficiency information for all

new light-duty vehicles under 3 864 kg gross vehicle weight.

Administrative aspects of the program, such as the collection of data from companies and the guidelines for the fuel consumption test procedure, are the responsibility of Transport Canada. NRCan is responsible for studying and recommending new targets, and providing consumer information through public education programs (e.g., *Car Economy Book*). Both departments fund the publication of the annual *Fuel Consumption Guide*. Although the new fleet fuel consumption exceeds the requirements of the standards when averaged across all companies, certain manufacturers are unable to individually meet the voluntary standard. These companies together represent less than two per cent of total sales. The CAFC targets mirror those in the United States, which have remained at 8.6 L/100 km since 1985. Canadian automotive suppliers have met or exceeded these targets.

Studies indicate fuel efficiency can be improved if industry has sufficient lead time. There is now an opportunity to discuss with the Canadian automotive industry the array of options available to achieve further gains in vehicle fuel efficiency.

Transportation Energy Efficiency

Purpose

To promote energy efficiency in the Canadian transportation sector.

Activities

NRCan promotes energy efficiency and reduced vehicle emissions in the transportation sector through a variety of demonstration, field audit, technology transfer and information programs.

The Pro-Trucker Program trains fleet drivers on energy-efficient vehicle selection, maintenance and driving practices. The program is in all provinces except Alberta, where a program is being developed, and Ontario, which already has its own program. The cost is shared with the trucking industry and provincial governments, under the guidance of regional advisory committees. Training responds to regional needs, with instructors from trucking associations and driver training schools.

The Pro-Fisher Program encourages energy efficiency in the marine sector through workshops on energy-efficient vessel selection and operation, and selected demonstrations. The cost is shared with provincial governments.

The Driver Education Awareness Program encourages fuel economy among motorists through the distribution of consumer information materials and an exhibits program.

The Transportation System Management Initiative encourages the reduction of fuel consumption and vehicle emissions through system management initiatives like car and van pooling, and the promotion of alternative modes of transportation.

Achievements in 1992-93

- Evaluated the Pro-Trucker Program and found that more than 95 per cent of participants have realized fuel savings. Approximately 2 600 drivers were trained during this period and some 10 000 drivers have been trained to date.
- Funded several demonstrations to identify energy-efficient opportunities for small fishing vessels.
- Developed and delivered a Pro-Fisher pilot workshop.

*The Pro-Trucker
Program trains fleet
drivers on energy-
efficient vehicle
selection, maintenance
and driving practices.*

- Issued the 1993 *Fuel Consumption Guide* with Transport Canada.
- Undertook a study to establish the need for material targeted to novice drivers.

Transportation Efficiency R&D Program

Purpose

To support the development and commercialization of vehicle technologies that will contribute to reduced fuel consumption and a cleaner environment.

Activities

Through the Transportation Efficiency R&D Program, NRCan supports the development of high fuel-efficiency, low-emission vehicles that incorporate advanced technologies, such as continuously variable transmissions, low-power auxiliaries and more efficient manufacturing. This support includes direct funding and cost-sharing of projects with industry, especially small- to medium-sized, technology-based companies. The program also fosters communication among component manufacturers, fuel suppliers, industry associations, fleet managers, universities, research institutes, equipment manufacturers and

government. Other program activities are standards development and technology transfer to promote awareness of advances among potential users. Fleet operators and automobile manufacturers have been targeted as clients most likely to benefit from the program.

Achievements in 1992-93

- Completed testing and emissions sampling on a joint project with Ortech International, Environment Canada and the Canadian Petroleum Products Institute to correlate the composition of diesel fuel with emissions to help define future diesel fuel standards.
- Equipped 50 vehicles with Autologgers (which measure detailed vehicle trip activities), as part of a pilot vehicle activity survey with Transport Canada and Environment Canada to derive representative driving cycles for improved fuel consumption and emissions testing.
- Installed particulate traps and completed initial emissions testing for eight Ottawa-Carleton (OC) Transpo buses under a joint project with OC Transpo, Environment Canada, the Ontario Ministry of Transportation, Donaldson Corporation, Detroit Diesel Corporation and Les Autobus MCI (now NovaBus).

Fleet operators and automobile manufacturers have been targeted as clients most likely to benefit from the Transportation Efficiency R&D Program.



Alternative Energy Sources

In the short term, improved energy efficiency can make a significant contribution to energy savings and environmental objectives. In the longer term, however, holding atmospheric emissions in check will likely require fundamental changes in the way we produce and use energy. That may mean, in part, a significant increase in reliance on alternative energy sources.

Alternative energy is generally defined as including non-conventional renewable sources, such as solar, wind, geothermal and tidal energy, small hydro, bioenergy and photovoltaic conversion systems. In addition, the term covers new transportation fuels (such as ethanol from renewable energy sources) and new applications of conventional energy sources (such as the use of propane and natural gas as automotive fuels, and batteries in electric vehicles). While alternative energy sources are generally held to be less environmentally damaging than conventional energy, this is not always true and careful attention must be paid to the environmental impacts of specific alternative energy activities.

Renewable energy, mainly biomass, supplies about five to seven per cent of total primary energy demand in Canada. The pulp and paper industry uses biomass (wood and pulping wastes) for about half of its energy requirements. The use of wood for residential space heating can be significant in certain regions of the country. There are a number of small hydro installations in some provinces, while wind, solar and earth energy remain in limited use. It is expected that all these energy sources will be used more in the future, but biomass energy

will enjoy the strongest industrial base. NRCan's principal form of support for renewable sources of energy is participation in R&D, along with some fiscal support through the tax system. The department is now reviewing its renewable energy policy, in consultation with members of the industry.

Propane and natural gas are used directly in vehicles converted to their use. The alcohol fuels, ethanol and methanol, can be used directly but, at present, are mainly used as extenders in gasoline blends. Alternative transportation fuels (ATFs) currently account for about two per cent of Canadian transportation energy use. Significant market momentum is building in the United States for ATFs, as a result of serious air quality problems in some major urban areas. The Canadian industry may benefit from growth in the U.S. market, especially in the conversion and manufacture of ATF vehicles.

NRCan's current approach to encouraging greater use of ATFs through R&D and demonstration, conversion and infrastructure grants and information is largely a continuation of activities begun in the early 1980s. The industry also benefits from the exemption of ATFs from federal excise taxation and, in some provinces, from road taxes.

Propane

Purpose

To promote the use of propane as a vehicle fuel in Canada.

Activities

With the Canadian propane industry, NRCan is presently undertaking two initiatives to encourage Canadians to buy

*Renewable energy,
mainly biomass,
supplies five to
seven per cent of total
primary energy
demand in Canada.*

propane vehicles. The first focuses on factory-produced propane vehicles. An agreement signed by NRCan, the Ontario government, members of the propane industry and Chrysler Canada has led to the production of a propane concept vehicle. Planning is under way for the launch of a production propane vehicle in Canada by 1995.

NRCan's other major activity is the expansion of propane vehicle use in Atlantic Canada, a region of the country not well served by any of the ATFs. As a first step, NRCan and the Newfoundland government are helping Superior Propane conduct a market demonstration of light-duty propane vehicles on the island of Newfoundland. The Newfoundland project is designed to have as many as 2 000 vehicles operating on propane within a five-year period. In addition, studies are being undertaken to assess the potential for automobile propane in the three Maritime provinces.

Achievements in 1992-93

- Completed the first phase of work on Chrysler's propane concept vehicle. The concept vehicle is scheduled for completion early in 1994, with a decision to proceed with production vehicles expected to be taken by Chrysler Corporation shortly thereafter.
- On the Newfoundland propane demonstration project, installed ten state-of-the-art propane refueling stations across the island, opened three conversion centres and established a propane personnel training centre at the Cabot Institute of Technology in St. John's. Approximately 75 vehicles were operating on propane in Newfoundland by the end of the period.

Natural Gas

Purpose

To promote the use of natural gas as a vehicle fuel in Canada.

Activities

NRCan offers three programs to develop the Canadian market for natural gas vehicles. The natural gas utilities deliver the programs on behalf of the federal government.

- The Natural Gas Vehicle Program (NGVP) contributes up to \$500 for each vehicle converted to natural gas.
- The Natural Gas Vehicle Refuelling Appliance Program (NGVRAP) provides an additional \$1 000 toward the purchase and installation of a vehicle-refuelling appliance as part of a vehicle conversion-refuelling appliance package.
- The Natural Gas Fuelling Station Program contributes up to \$50 000 for each new public or private natural gas refuelling facility.

Achievements in 1992-93

- Funded the conversion of approximately 1 345 vehicles and 340 vehicle refuelling appliances.
- Funded more than 11 fuelling stations.

Methanol

Purpose

To establish an initial infrastructure of methanol fuelling stations for motor vehicles.

Activities

Government and industry set up a methanol light-duty vehicle program in 1991 to demonstrate the use of methanol

Ethanol and methanol can be used directly but, at present, are mainly used as extenders in gasoline blends.

as a vehicle fuel. The demonstrations will be in British Columbia, Alberta and Ontario. NRCan provides financial support to the program through the Canadian Oxygenated Fuels Association, which is a coalition of Canadian methanol producers. The association promotes the purchase of methanol vehicles by targeted fleets in Kamloops, Vancouver, Calgary and Toronto, where the program is set up. It also promotes the construction of methanol refuelling stations and the availability of methanol fuel at the retail level.

Achievements in 1992-93

- Provided funding for public access refuelling stations in Vancouver, Kamloops, Calgary and Toronto. Also provided funding for on-site refuelling facilities for fleet applications.
- Interested fleets purchased approximately 50 methanol passenger cars produced by General Motors of Canada Limited, Ford Motor Company of Canada Limited and Chrysler Canada Ltd.

Ethanol

Purpose

To encourage the production of ethanol from agricultural and other biomass feedstocks, and the use of ethanol as a gasoline blending component.

Activities

The government's ethanol initiative was announced in November 1992 by the ministers of agriculture and energy. An incentive to use ethanol from biomass was provided in the federal budget in the spring of 1992 when the excise tax of 8.5 cents/L was waived for blends of up to 10 per cent ethanol in gasoline.

Several federal departments are involved in the ethanol initiative, which is coordinated through the Interdepartmental

Steering Committee on Ethanol (ISCE), chaired by NRCan.

The following are activities under the ethanol initiative:

- The Bioenergy Development Program of CANMET sponsors projects that would improve the conversion of plentiful and inexpensive cellulosic (woody) biomass to ethanol and value-added chemicals. At the present time, there are six active projects for the development of key process steps. Among the projects recently completed is one by Stake Technology Limited to investigate the production of ethanol from waste paperboard. In addition, through the program, CANMET supports two pilot-scale projects: Queen's University's new fermentation process and Tembec's wood fermentation process. The intent is to demonstrate technology developed under the program and promote its transfer to the private sector.
- The process of developing and testing the technology for establishing willow energy plantations was investigated by the Canadian Forest Service of NRCan. Fast-growing woody species such as willow are a good feedstock for the production of ethanol.
- Two ethanol-fuelled urban transit buses were put into revenue service by Regina Transit in March 1991, a project co-funded with CANMET. This is the first project in North America where neat ethanol (100 per cent) is the fuel in heavy-duty engine applications. Furthermore, Environment Canada has conducted emission tests on three occasions to characterize emissions of the buses.
- The Prairie Agriculture Manufacturing Institute, in Manitoba, is proposing to conduct field trials of a tractor using neat ethanol, starting in March 1994. The project will receive financial support from CANMET and Environment Canada.

Two ethanol-fuelled urban transit buses were put into revenue service by Regina Transit in March 1991.

Achievements in 1992-93

- In association with the National Research Council, CANMET conducted an analysis for the southern Ontario region of the ground-level ozone problem of ethanol blending, using a simulation model.

Alternative Transportation Fuels R&D Program

Purpose

To support technology development for ATFs.

Activities

The program focuses on the development of competitive, energy-efficient and environmentally responsible technologies for gaseous fuels (natural gas and propane), alcohol fuels (ethanol and methanol) and advanced transportation systems (electric vehicles and batteries, fuel cells and hydrogen). The program, managed by CANMET, helps Canadian fuel suppliers and vehicle manufacturers develop innovative and marketable technologies through R&D, technical standards, field trials and technology transfer. Program clients include the Canadian transportation and energy sectors, small- to medium-sized enterprises concentrating on technology innovation, and Canadian-based divisions of North American original equipment manufacturers (OEM). Program participants include industry associations, utilities, provincial governments, research organizations, universities and other federal departments.

The program also promotes the use of ATF technologies with large potential users, including fleet managers and transit authorities.

Gaseous Fuels

Canadian equipment manufacturers and fuel suppliers are vying to participate in the OEM ATF market for propane and

natural gas – powered vehicles, set for 1995-96 introduction, through the supply of advanced, low-cost vehicle components and fuel supply technologies. CANMET helps this industry to commercialize technologies. Through its funding provisions (usually less than 20 per cent of total funding), it serves as a catalyst to bring interested parties together. As a result, a number of innovative technologies that could reduce the cost and increase the operating range of natural gas vehicles are under development. These include lightweight low-cost fuel storage cylinders, natural gas vehicle technologies for trucks and buses, fuel injection systems and electronic fuel management systems. NRCan's propane activities focus on the development of advanced technologies and technical standards.

Alcohol Fuels

NRCan is working with the Canadian divisions of North American OEMs, provincial governments and Canadian fuel suppliers to address technical problems that limit the marketability of ethanol- and methanol-fuelled vehicles. These problems include cold starting, inefficient fuel combustion leading to increased emissions, and corrosion on methanol engine parts and refuelling facilities. NRCan funds a number of projects studying these problems.

Advanced Transportation Systems

Hydrogen battery and fuel cells technology represent the 'zero-emission' vehicles of the future. The program links organizations with similar R&D objectives, as funding participants in consortia that are interested in researching these technologies. As demand grows for zero-emission vehicle technologies, continued R&D collaboration among interested parties will be critical to secure a market share for Canada as a supplier of advanced technology systems.

As demand grows for zero-emission vehicle technologies, continued R&D collaboration will be critical to secure a market share for Canada.

Achievements in 1992-93

- Established a research consortium with the Canadian Gas Association and General Motors of Canada Limited to develop an advanced natural gas vehicle. Entered into a similar agreement with Chrysler Canada Ltd. to develop a second-generation propane van.
- Began work for the field trial of the world's first hydrogen-powered bus, incorporating advanced fuel-cell technology developed by Ballard Power Systems Inc. of Vancouver.
- EDO (Canada) Limited of Calgary gained certification in Alberta for its lightweight natural gas storage cylinder, developed with CANMET support, allowing the firm to market this product. The cylinder should significantly increase the range and fuel efficiency of natural gas vehicles.
- Helped to initiate the development of a plasma ignition system (a high-intensity replacement for conventional spark plugs) for methanol-fuelled vehicles, as a member of an R&D consortium with British Gas Holdings (Canada) Ltd., Petro-Tire and Ortech Corporation. This method shows promise for improving cold starting and facilitating the use of neat (100 per cent) methanol, thereby decreasing emissions.
- Continued funding several field trials of alternatively fuelled transit buses, including two ethanol buses in Regina and six methanol buses in Windsor.

Renewable Energy Market Assessments

Purpose

To undertake a complete review of renewable energy use, resources and commercially available technologies

and to establish their potential for meeting energy and environment goals.

Activities

The Renewable Energy Market Assessments initiative addresses the potential of solar, wind, geothermal, tidal and small hydro power, bioenergy and biomass waste resources and technologies to contribute to environmental objectives. Activities include:

- compiling data on current demand and use;
- compiling data on supply constraints relative to demand;
- evaluating market prospects for available and new technologies; and
- developing strategies to increase the ability of the renewable energy sector to match products and supply in identified markets.

The program is industry driven. Suppliers of renewable energy equipment and system designers, or their representatives, are invited to submit proposals for co-funded analyses of broad market identification. To meet the data requirements of the program, the program also initiates a series of studies in consultation with interested parties and potential users.

Achievement in 1992-93

- Funded three market studies to assess the potential and constraints for the development of ethanol. Canadian Agra conducted a consumer interest survey on fuel ethanol for southwestern Ontario (1992) and western Canada (1993). The results show that there is an important market for ethanol fuel. Also, Sunoco has recently completed a study on the technical and economic considerations in producing low-level ethanol blends at the terminal and the refinery.

CANMET has begun work for the field trial of the world's first hydrogen-powered bus.

Information and Awareness

Purpose

To expand the use of renewable energy technologies.

Activities

Awareness of renewable energy will help to ensure the greater use of these technologies and stimulate industry growth. Program activity focuses on examining the information needs of various groups (e.g., the public, the renewable energy industry) and preparing targeted information showing how these technologies can be economically and reliably applied to meet some of our energy needs.

To avoid duplication of effort, NRCan negotiates access to existing materials and works in cooperation with environmental groups, trade associations, provinces and other strategic allies to market information packages.

The operation of the Information and Awareness component of this initiative is integrated into the general Consumer Awareness service that supports all EAE programs.

Achievements in 1992-93

- Reviewed and reprinted existing publications on solar energy and biomass.
- Contracted with the Canadian Wood Energy Institute (CWEI), in a joint initiative with the Canada Mortgage and Housing Corporation (CMHC), to research and write a new edition of the popular *A Guide to Residential Wood Heating*. This book has been marketed by NRCan, CMHC, CWEI, fire departments and the wood-heating equipment and insurance industries. It is also being distributed to aboriginal groups across Canada.

Canada - Prince Edward Island Cooperation Agreement on Alternative Energy Development and Energy Efficiency

Purpose

To enhance energy security and energy-use efficiency in Prince Edward Island; to increase production of renewable energy from local resources; to stimulate local employment, entrepreneurial and industrial opportunities in wood chip harvesting and transportation; and to promote biomass-heating-system fabrication and engineering.

Activities

The Energy Diversity Program provides technical and financial support to the conversion of existing commercial and institutional heating systems and the installation of new systems to use island biomass fuels. The Energy Efficiency Program implemented with Prince Edward Island's two electrical utilities, Maritime Electric Co. Ltd. and the Summerside Electrical Utility makes more efficient use of Prince Edward Island's energy supply. The Commercialization Program is federally funded and gives technical and financial support to entrepreneurs to commercialize products and services that show promise in the EAE sector.

Achievements in 1992-93

- Funded six small biomass projects with installations on farms and small commercial enterprises.
- Tested a number of boiler types for performance and emission levels.

The Energy Efficiency Program implemented with Prince Edward Island's two electrical utilities makes more efficient use of Prince Edward Island's energy supply.

- Refined the Retrofit Energy Analysis Program (REAP) lighting energy-audit software and a small-scale vertical tube boiler and heating system.

Renewable Energy Technologies Program

Purpose

To support Canadian industry in developing and commercializing renewable energy technologies.

Activities

The technologies under this program consist of bioenergy (including combustion, biochemical conversion of biomass to ethanol, thermochemical conversion and biomass production and handling), small hydro (less than 20 megawatts), active solar, photovoltaics and wind energy. The Renewable Energy Technologies Program (RETP) supports, on a cost-sharing basis, technology development and field trials with the renewable energy industry. Program participants include universities, utilities, trade associations, other federal and provincial departments, and research institutes. Laboratory services in photovoltaics are offered by CANMET's EDRL in Varennes, Quebec.

The program focuses on two areas: the advancement of renewable energy technologies in the Canadian marketplace and the exploitation of international opportunities. NRCan conducts technology transfer within the industry and among potential users through field trials, workshops, seminars and trade shows. The department also participates in the development of technical standards that help remove trade barriers to international markets.

Achievements in 1992-93

- Developed an infrared temperature-monitoring device to improve a wood-waste boiler's efficiency, with funding from RETP, MPB Technologies Inc. of Montreal and MacMillan Bloedel Ltd. of Vancouver.
- Supported Enslyn's development of a proprietary, leading-edge Rapid Thermal Process. Enslyn has installed the world's first commercial 25 tonne-per-day plant and is currently finalizing negotiations with the European Community for a demonstration plant to accelerate introduction of this technology into Europe.
- Developed in cooperation with Conserval Engineering Inc. a perforated solar absorber for Solarwalls resulting in a 40 per cent improvement in cost performance compared with conventional solar air-heating technology. The technology has been licensed to Alcan Aluminum Limited and has already attracted sales from major clients including Ford, General Motors and Bombardier.
- Co-founded the Hydro Turbine Group in the Centre de recherche en calcul appliqué with General Electric Canada, GEC Alsthom Électromécanique Inc., Institut de recherche en électricité du Québec, University of Montreal, Concordia University and McGill University.
- Supported Iogen Corporation in the development of world expertise in the production of cellulose enzymes that can be used in the production of fuel ethanol from wood wastes.

the Renewable Energy
Technologies Program
supports technology
development and field
trials with the renewable
energy industry.



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*Report to Parliament
on the Administration
and Enforcement
of the*

Energy Efficiency Act

1993-94



His Excellency the Right Honourable Roméo LeBlanc,
P.C., C.C., C.M.M., C.D., Q.C.
Governor General of Canada
and Commander-in-Chief

Your Excellency:

I have the honour to present the *Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act* for the fiscal year ending March 31, 1994, in accordance with section 36 of the act.

Respectfully submitted,

A handwritten signature in dark ink, reading "A. Anne McLellan". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

A. Anne McLellan
Minister of Natural Resources

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Loi sur l'efficacité énergétique, 1993-1994*

Minister's Foreword



We all use and rely on energy for our standard of living and for our comfort.

In the past, Natural Resources Canada¹ (NRCan) has been concerned with assuring Canadians a reliable supply of reasonably priced energy. This remains an important energy policy objective. However, we now have a better appreciation of the environmental impacts of energy supply, transport and use. Sustainable development has therefore become another key objective of our energy policy.

In the short term, improved energy efficiency can make a significant contribution to meeting our environmental objectives. In the longer term, holding atmospheric emissions in check will likely require fundamental changes in the way we produce and use energy. That may mean, in part, increased reliance on alternative energy sources — renewable energy and alternative transportation fuels.

This document reports on my department's activities to promote energy efficiency and the use of alternative energy. During 1993–94, the department made progress on 33 initiatives to encourage the adoption of energy-efficient and alternative energy practices and technologies in all sectors of the Canadian economy. These initiatives were carried out under the authority of the *Energy Efficiency Act*. This is the second report under the act. I tabled the first report before Parliament in April 1994. This progress includes, for example, the following initiatives:

- published for comment the first regulations under the *Energy Efficiency Act*, which would establish energy-efficiency performance levels for and require energy consumption labelling of prescribed products;
- signed letters of cooperation on the delivery of energy-efficiency and alternative energy programs with the Department of Energy and Mines in Saskatchewan and the Department of Natural Resources in Nova Scotia; and
- worked with industry to build 10 of the most energy-efficient and environmentally responsible Advanced Houses in the world.

This report sets out NRCan's achievements from April 1, 1993 to March 31, 1994. Since then, however, I have expanded several key initiatives that are voluntary, provide long-term solutions to environmental issues and stimulate economic activity:

- Through our **Federal Buildings Initiative (FBI)**, we help federal government departments and agencies improve the energy efficiency of their facilities. I have written to my federal colleagues with custodial responsibility, and they have committed to keep the FBI high on their departmental agendas. I have instructed my officials to ensure that NRCan becomes the most energy-efficient department in the federal government.

¹ Under the Federal Identity Program, "Natural Resources Canada", abbreviated as NRCan, has been approved as the applied title of the Department of Natural Resources.

-
- We are encouraging other orders of government to take advantage of the FBI. I have written to my provincial colleagues to encourage them to make energy efficiency a priority. NRCan has entered into an agreement with the Federation of Canadian Municipalities to promote energy-efficiency initiatives in municipalities across the country, and the FBI model is being used in the commercial and institutional sectors through the Energy Innovators Program.
 - Through my Minister's Advisory Council on Industrial Energy Efficiency and the Canadian Industry Program for Energy Conservation, Canadian industry is developing energy-efficiency targets and plans at the sectoral level. This Council represents more than 85 per cent of industrial energy use in Canada.

I want Canadians to understand what we are doing in energy efficiency and alternative energy and why. I want Canadians to understand how important they are — as employers, employees and citizens — in the drive to meet our energy and environmental objectives. These objectives include the stabilization of greenhouse gas emissions that contribute to global warming.

I am very pleased with the progress made to date in support of energy efficiency and alternative energy. The 33 initiatives outlined in this report provide the type of innovative leadership required to respond to our climate change commitments. A number of major foundation measures are now in place that are having results. It is a strong base on which governments and the private sector can build.

Just as I encourage my fellow ministers and the officials of my department to make wiser use of energy resources, I encourage you to do the same. There are few better examples of how to achieve a sustainable legacy for future Canadians.

A. Anne McLellan
Minister of Natural Resources

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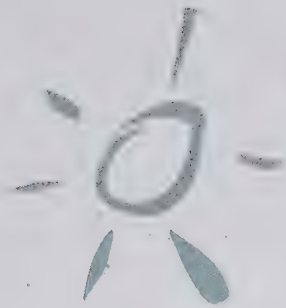
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Background and Policy Context

Overview

Natural Resources Canada (NRCan) supports energy efficiency and alternative energy (EAE) to help meet the government's energy, environmental and economic policy objectives.

To put the department's efforts in context, chapter one describes the federal approach to EAE. It also outlines NRCan's strategy to encourage Canadians to invest in greater energy efficiency and alternative energy. Chapters two through seven describe NRCan's EAE program initiatives. These are managed by the Energy Sector (Efficiency and Alternative Energy Branch) and the

Efficiency and Alternative Energy Technology Branch and the Energy Research Laboratories of the Canada Centre for Mineral and Energy Technology (CANMET).

This second *Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act* covers April 1, 1993 to March 31, 1994. For discussion of environmental issues, market barriers to EAE and recent developments in energy efficiency, the reader is encouraged to consult the first annual report. It covers September 1, 1992 to March 31, 1993, and was tabled in Parliament on April 20, 1994.



Chapter One Introduction

The Energy Efficiency Act

On June 23, 1992, Royal Assent was given to the federal government's *Energy Efficiency Act*. The act provides for the making and enforcement of regulations concerning EAE, primarily:

- minimum energy-efficiency performance standards for energy-using products, doors and windows;
- the labelling of energy-using products, doors and windows to convey information on their energy efficiency; and
- the collection of statistics and information on energy use and alternative energy.

Section 21 of the act, which came into force September 1, 1992, gives the Minister the authority to promote EAE. (The rest of the statute came into force January 1, 1993.)

Section 36 requires the Minister to table an annual report before Parliament on the previous fiscal year's administration and enforcement of the act. This document is the second annual report submitted under this legislation. It reports on activities undertaken to promote EAE during the fiscal year ending March 31, 1994.

The Federal Approach to EAE

Throughout the 1970s and into the 1980s, the federal government used fiscal measures and energy price controls to pursue security of energy supply and soften the impact on the economy of rapidly rising energy prices. This approach included steadily increasing support for greater energy efficiency and the use of alternative energy sources.

By the early 1980s, it was apparent that producers and consumers had responded to energy price signals and various forms of government encouragement to discover new

reserves on the supply side, and conserve energy on the demand side. Price forecasts for conventional energy flattened out, security concerns abated and serious fiscal constraints emerged. Consequently, federal energy policy turned toward more market-oriented alternatives.

Toward the end of the 1980s, countries around the world began to accept that atmospheric emissions from fossil fuel use contribute to global warming. This led Canada and a number of other countries to sign the United Nations' Framework Convention on Climate Change in 1992. In response, NRCan expanded its support for EAE, building on the department's long experience in designing and managing EAE programs. This program expansion took into account:

- the need for flexibility, not only as programs mature, but also as our understanding of the implications of EAE opportunities and the environmental impacts of energy supply and use improves;
- international competitiveness and trade commitments; and
- the need for consistency with other policy objectives, especially fiscal restraint.

The EAE program encourages investment in corporate and consumer EAE opportunities and seeks to engage all sectors of the economy and the public in rethinking how they use energy. The program uses a variety of policy instruments, such as information, suasion, R&D and regulation. In all cases, it emphasizes partnership with stakeholders, such as provinces, industry and non-governmental organizations. In this manner, the program helps the demand side of the energy market

The EAE program encourages investment in corporate and consumer EAE opportunities and seeks to engage all sectors of the economy and the public in rethinking how they use energy.

move toward more energy-efficient capital stock, production processes and operating practices, without reducing the level of service or comfort that energy provides. On the supply side of the energy market, the program ensures Canada's participation in the development of technologies for tapping alternative sources of energy.

NRCan's EAE program also provides a foundation for the longer-term processes that can respond to evolving environmental and economic development priorities. The department has enhanced its statutory authority, improved its data-gathering and analytical capabilities, and forged stronger information and planning frameworks with the provinces and other strategic allies.

In November 1993, federal, provincial and territorial energy and environment ministers instructed their officials to prepare options for stabilizing Canada's greenhouse gas emissions by 2000, and propose ways of reducing emissions by 2005. A task group representing stakeholders was formed to develop these options and to report to ministers through the National Air Issues Coordinating Mechanism by the fall of 1994.

Energy Efficiency Strategy

Many of NRCan's EAE initiatives deal solely with energy efficiency. These are presented in chapters three through six according to end-use sector: buildings, equipment, industry and transportation. The strategy aims to improve energy efficiency by:

- upgrading the energy efficiency of new and existing buildings, equipment, systems and vehicles;
- ensuring that energy-consuming appliances and equipment are used in the most energy-efficient way (e.g., keeping furnaces well-tuned, operating vehicles at optimal speeds);
- influencing the choices of individuals and organizations (e.g., to purchase more energy-efficient equipment); and

- modifying the daily energy-use practices of individuals and organizations (e.g., to use public transit instead of personal vehicles).

The key policy tools employed by NRCan are:

- regulation — setting minimum energy-efficiency standards for certain types of equipment and buildings (with provincial governments);
- information — targeting information programs to specific groups of energy consumers;
- suasion — setting energy-efficiency objectives for vehicles, companies and institutions; and
- R&D — providing support for the development and deployment of more energy-efficient equipment, processes and technologies.

Figure 1.1 shows how these policy tools work together to reduce the amount of energy needed to obtain a certain level of service. Regulations eliminate the less energy-efficient items from the marketplace. Information and suasion convince consumers to purchase the most energy-efficient items available and to use them correctly. R&D creates more energy-efficient technologies for the marketplace.

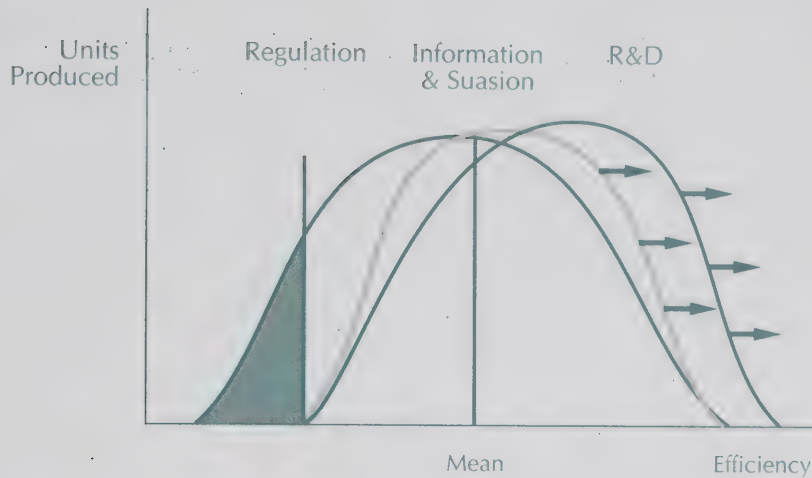
Alternative Energy Strategy

In the short term, improved energy efficiency can make a significant contribution to energy savings and environmental objectives. In the longer term, however, holding atmospheric emissions in check will likely require fundamental changes in the way we produce and use energy. That may mean, in part, a significant increase in reliance on alternative energy sources.

Alternative energy includes renewable sources of energy (e.g., bioenergy, solar) and new applications of conventional energy sources (e.g., natural gas used as an automotive fuel).

■ ■ ■ ■ ■
The EAE program
helps the demand side
of the energy market
move toward more
energy-efficient capital
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processes and
operating practices,
without reducing the
level of service or
comfort that energy
provides.

Figure 1.1
Moving the Market



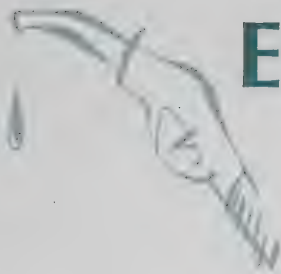
Source: Natural Resources Canada.

Some technologies, especially for propane and forestry biomass, are commercially available and accepted. Some have found applications in specialized markets, such as remote communities. Other technologies are in the early stages of development. Chapter seven describes NRCan's measures to help develop and encourage the use of alternative sources of energy.

NRCan's alternative transportation fuel activities are directed toward the most technically promising alternatives that have strong potential for market application. These include propane, natural gas, methanol and ethanol. Federal initiatives are helping to expand the infrastructure (e.g., availability at fuel stations) for these fuels and their markets, especially in urban regions with air-quality problems that

can be alleviated through greater use of alternative transportation fuels. R&D continues to examine ways to improve the near- and long-term options for these fuels. The longer-term options include hydrogen, fuel cells and electric vehicles.

Renewable energy sources, such as bioenergy, hydraulics, and solar and wind technologies are generally recognized as important potential contributors to the reduction of global warming. NRCan's support for renewable energy is allocated largely to R&D to reduce costs, improve performance, develop safety and performance standards, and increase the scope for renewable energy technologies. Other activities involve providing reliable information to buyers, and assessing economic and environmental factors.



Efficiency and Alternative Energy Programs

Overview

Chapter one sets out the context and policy framework for NRCan's EAE program. The remaining chapters describe each of NRCan's 33 EAE program initiatives. Chapter two outlines four initiatives that relate both to energy efficiency and to alternative energy. Chapters three to six detail 20 energy-efficiency initiatives in the four sectors that use energy: buildings, equipment, industry and transportation. Chapter seven sets out program initiatives geared to increasing the use of alternative energy: five initiatives on alternative transportation fuels and four on renewable energy.

For each of the 33 program initiatives, this report sets out their:

- purpose — what they are trying to achieve; and
- achievements from April 1, 1993 to March 31, 1994.

In undertaking its EAE program activities, NRCan cooperates closely with provincial and territorial departments of energy. This work takes place on several levels:

- NRCan managers and staff working with their provincial and territorial counterparts on specific program initiatives;
- NRCan developing a bilateral relationship with interested provinces or territories in terms of the overall delivery of EAE program initiatives (as of March 31, 1994,

NRCan had signed letters of cooperation on EAE program delivery with the Department of Energy and Mines in Saskatchewan and the Department of Natural Resources in Nova Scotia);

- NRCan participating as a member of the intergovernmental Conservation and Renewable Energy Subcommittee (CARES) under the Advisory Committee on Energy; and
- NRCan receiving advice on R&D matters from provinces and other stakeholders participating in technical or business advisory committees (e.g., the Minister's National Advisory Council to CANMET).

Other federal departments foster EAE beyond the initiatives outlined in this report. For example, other federal departments conduct EAE research activities under the Panel on Energy Research and Development. Tax relief provisions, such as the absence of a fuel excise tax on natural gas, propane, neat methanol, ethanol and the alcohol portion in ethanol- and methanol-gasoline blends, are another measure. And Class 34 (now Class 43) of the *Income Tax Act* provides an accelerated capital cost allowance for several energy-efficient and renewable energy technologies in certain circumstances.

Table 2.1
EAE Program Initiatives and Expenditures for 1993-94
(\$ million)

General Programs	5.2	Industry Energy R&D	
Consumer Information		Industry Targeted Program	
Partnership in Integrated		Gas Technologies Program	
Resource Planning			
Advanced Integrated Energy Systems			
Technologies Initiative			
National Energy Use Database			
Buildings	11.9	Transportation	1.9
Federal Buildings Initiative		Motor Vehicle Fuel	
National Energy Codes for Buildings		Consumption Standards	
and Houses		Transportation Energy Efficiency	
R-2000 Home Program		Transportation Efficiency R&D Program	
Energy Innovators Initiative			
Building Information Transfer		Alternative Energy: Alternative	
Federal Industrial Boiler Program		Transportation Fuels	9.5
Buildings Energy Technology		Propane	
Advancement Plan		Natural Gas	
- Residential		Methanol	
- Commercial		Ethanol	
- Passive Solar		Alternative Transportation Fuels R&D	
Heat Management Program		Program	
Equipment	2.3	Alternative Energy: Renewable	
Efficiency Standards for Equipment		Energy Sources	9.2
EnerGuide		Renewable Energy Market Assessments	
		Information and Awareness	
		Canada - Prince Edward Island	
		Cooperation Agreement on Alternative	
		Energy Development and Energy	
		Efficiency	
		Renewable Energy Technologies Program	
Industry	7.6	TOTAL	47.6
Industrial Energy Efficiency			
Canadian Energy Management and			
Environmental Training Program			

Note: This table presents estimated NRCan expenditures during fiscal year 1993-94 on EAE initiatives by end-use sector or by type of alternative energy (several initiatives that cover all or many sectors are listed under "general programs"). The expenditures are based on funds received from several sources: the Green Plan, Panel on Energy Research and Development, A-base (basic operating budget), Market Development Incentive Payments and sunset programs (those with established completion dates).



Chapter Two General Programs

Consumer Information

Purpose

To make Canadians aware of the link between energy use and the environment, and to encourage the use of energy-efficient practices and alternative forms of energy.

Achievements in 1993-94

- Distributed more than 1.4 million copies of the 300-plus EAE publications either directly to individuals or through program allies.
- Produced a series of articles, in collaboration with the Canada Mortgage and Housing Corporation, Environment Canada and PowerSmart utilities, for newspaper supplements on energy efficiency. The articles discussed home energy improvements, energy-efficient office equipment, purchasing energy-efficient appliances and R-2000 Homes. The supplements were delivered to almost three million Canadian households.
- Produced and distributed 60 000 copies of the Energy and the Environment Calendar, featuring children's drawings promoting energy efficiency and environmental tips.
- Coordinated the production and printing of the Canadian Energy Education Directory, documenting educational reference materials and services available from Canadian organizations.

Partnership in Integrated Resource Planning

Purpose

To bring together stakeholders to support demand-side management by promoting energy-efficiency methods and practices in the industrial, commercial and institutional sectors. To identify, create and maintain training, technical information and financial

services to support the efforts of the Energy Innovators Initiative, the Federal Buildings Initiative (FBI) and the Industrial Energy Efficiency Initiative.

Achievements in 1993-94

- Established more than 30 new alliances with energy management firms, manufacturers, electrical and natural gas utilities, and community colleges.
- Formed working groups with energy management firms, utilities and others to explore ways of accelerating energy management investment in Canada.
- Organized *Innovative Partners in Energy Efficiency Day*, involving allies and decision makers from federal government departments, to speed up the adoption of FBI projects in federal government facilities.

Advanced Integrated Energy Systems Technologies Initiative

Purpose

To develop technology, financing and marketing options for integrated community energy systems and suggest ways of implementing them.

Achievements in 1993-94

- Completed feasibility studies showing the economic and technical viability of a biomass-fired district heating system in the Ojibway community of Grassy Narrows.
- Held major community energy systems conferences in Toronto and Halifax. With other promotional efforts, the Halifax conference persuaded Nova Scotia Power to work with CANMET on a preliminary design for converting the Tuft's Cove

A series of articles,
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power plant to provide heat for a district heating system in Dartmouth. This will be the first district heating system in Canada that is utility-based and uses modern hot water technology.

- Completed the first phase of a district energy study for Metropolitan Toronto. This work, done with Ontario Hydro and Metropolitan Toronto, demonstrates that the system is feasible. It would be one of the world's larger district energy systems.
- Constructed North America's first ice slurry district cooling system at CANMET's Energy Research Laboratories in Bells Corners (near Ottawa), with the support of the Province of Ontario and Environment Canada. The system demonstrates Canadian-developed technology and provides technical information.
- Completed feasibility studies for district energy systems in Regina and Saskatoon. The studies demonstrated that the projects would be viable if SaskPower would buy back the electricity.
- Completed a pre-feasibility study for the Davis Inlet Innu community on using diesel engine heat for space and hot water heating for existing or new communities.

National Energy Use Database

Purpose

To improve the state of knowledge on energy consumption in Canada.

Achievements in 1993-94

- Held a workshop in Hull, Quebec, on the potential for energy efficiency in Canada. The workshop provided a forum to exchange information on the potential of and the barriers to energy efficiency. About 100 people attended from the federal and provincial governments, energy utilities and research institutes.

- Provided funding to Statistics Canada, which completed the first national Survey of Household Energy Use. The survey provides information on the characteristics of household equipment and housing. Statistics Canada conducted the survey for NRCan and five participating provinces as a supplement to the Labour Force Survey.

- Formulated the National Private Vehicle Use Survey to gather information on private vehicle use. The survey will collect information on vehicle characteristics and fuel consumption, distance driven, and driver characteristics and behavior. Statistics Canada completed a feasibility study and scheduled initial field work for October 1994.

- Created the Canadian Commercial Energy End-Use Data and Analysis Centre at McMaster University. The mandate of the centre is to:

- organize existing data on energy-using equipment and buildings;
- identify major information gaps;
- propose a data collection strategy to supplement existing information sources; and
- establish a base of expertise for the analysis of energy use in the commercial sector in Canada.

- Established the Canadian Agricultural Energy End-Use Data and Analysis Centre at the University of Saskatchewan. The centre will improve knowledge about energy use and energy efficiency in Canada's agricultural sector, and will pursue, in its area of expertise, the same objectives as those at McMaster.

- Funded other Canadian centres:

- the Automobile Mobility Data Compendium at Laval University, which focuses on the use of privately owned vehicles; and

■ ■ ■ ■ ■

The Halifax

conference persuaded

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the Tuft's Cove power

plant to provide heat

for a district heating

system in Dartmouth.

-
- the Canadian Industrial Energy End-Use Data and Analysis Centre at Simon Fraser University, which examines patterns of energy use by industry.
 - Signed an agreement with Statistics Canada to revise the Industrial Consumers of Energy (ICE) Survey by expanding the coverage from 230 to 1000 establishments, and identifying the use of middle distillates and purchased electricity by industrial subsector.
 - Collaborated with Hydro-Québec on its Eval-ISO project, which collected information on the thermal envelope characteristics of Quebec housing stock and how the thermal envelope affects energy consumption, and estimated energy-efficiency potential in Quebec's residential sector. NRCan's involvement was to expand the project beyond electric heating to include homes heated by gas and fuel oil.



Chapter Three Buildings

Building Energy Use

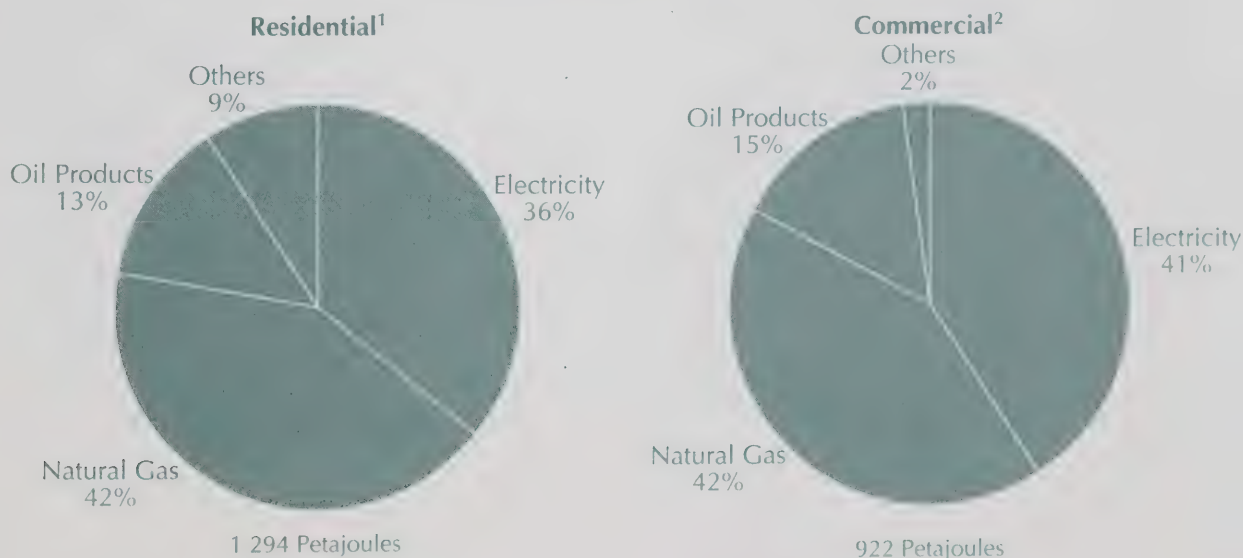
For purposes of energy discussion, a building is a system comprising a building envelope, architectural features, mechanical equipment and occupants. The building envelope is made up of all the materials and surfaces in the building shell, including walls, ceilings, roof, basement walls, windows and doors. The architectural features determine the degree to which the building gets energy from the sun. Mechanical equipment is the energy-using component of the system. It includes all the equipment and appliances related to space heating and cooling, ventilation, lighting, water heating, cooking and humidifying. The interaction of the building envelope, the architectural features, the mechanical

equipment and the energy practices of the occupants determines the overall energy use of the building. This chapter focuses on these aspects of energy efficiency.

Energy use can be classified as primary and secondary. Primary energy use is the total requirement for all uses of energy. This includes energy used by consumers, in the transformation of one energy form to another and by suppliers to deliver energy to the market. Secondary energy use refers to the energy used by final consumers in the residential, commercial, industrial and transportation sectors. The EAE program is concerned only with secondary energy use.

Energy use in residential and commercial buildings in 1992 amounted to 33 per cent of total Canadian secondary energy use.

Figure 3.1
Residential and Commercial Energy Use by Fuel, 1992



1 - Excludes farm motive use.

2 - Excludes aviation fuels, diesel fuel oil and motor gasoline.

Sources: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada, Cat. No. 57-003, 1992-IV.

Natural Resources Canada, Residential End Use Model.

Natural Resources Canada, Commercial End Use Model.

Energy use in residential and commercial buildings in 1992 amounted to 2216 PJ, equal to 33 per cent of total Canadian secondary energy use. Residential buildings accounted for 1294 PJ (19 per cent), while commercial buildings consumed 922 PJ (14 per cent).

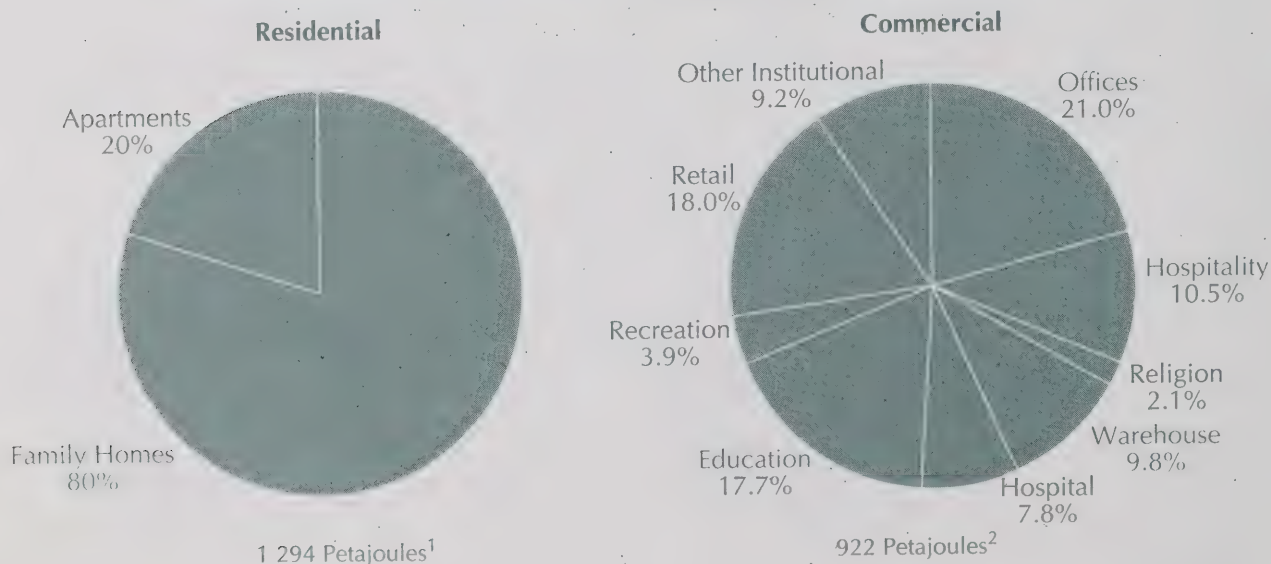
Although residential and commercial buildings differ substantially in the way they consume energy, they are similar in the fuel mix they use (see Figure 3.1). Natural gas is the dominant fuel in the residential and commercial sectors, accounting for 42 per cent of energy use in each sector.

In the residential sector, electricity accounts for the second-largest share (36 per cent), and oil accounts for the third-largest share (13 per cent).

In the commercial sector, the importance of electricity has increased and now represents 41 per cent of energy use. Oil accounts for 15 per cent of commercial energy use.

Figure 3.2 compares Canadian residential and commercial building energy use for different building types. In the residential sector, family homes are the major energy-using group. In the commercial sector, energy use occurs in diverse market segments and building types, with retail, education and office buildings accounting for more than half of commercial energy use.

Figure 3.2
Residential and Commercial Energy Use by Building Type, 1992



1 - Excludes farm motive use.

2 - Excludes aviation fuels, diesel fuel oil and motor gasoline

Sources: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.

Natural Resources Canada, Residential End Use Model.

Natural Resources Canada, Commercial End Use Model.

Federal Buildings Initiative

Purpose

To help government departments and agencies improve the energy efficiency of their facilities.

Achievements in 1993-94

- Conducted workshops for federal facility managers and operating personnel in all regions of the country. The workshops gave participants the knowledge and skills to conduct energy assessments, prepare training programs for personnel, develop and implement employee information and awareness programs, prepare requests for proposals, and negotiate energy service contracts.
- Initiated a Quick Start campaign to expedite the implementation of energy-efficiency projects in federal departments. The campaign is intended to identify energy-efficiency opportunities in collaboration with federal facility managers to expedite the implementation of pilot projects. The Quick Start function will evolve into a project support service for federal departments during the full implementation phase.
- Implemented an energy-efficiency pilot project in 9 of the 11 federal custodial departments.
- Established strategic alliances with energy utilities and industry associations such as PowerSmart and the Canadian Association of Energy Service Companies to assist the FBI with energy-efficiency workshops and pilot project implementation in federal departments. The alliances were instrumental in assisting the FBI in developing products and services that address barriers to implementing projects.

National Energy Codes for Buildings and Houses

Purpose

To increase the energy efficiency of Canadian buildings by specifying minimum levels of thermal performance, and promoting the

incorporation of these codes into provincial and municipal building regulations.

Achievements in 1993-94

- Co-funded research for the development of the energy codes with utilities, provincial ministries of energy and other stakeholders.
- Disseminated information on the energy codes to builders, designers and other stakeholders through promotional materials, a travelling exhibit and a Speaker's Bureau, which provided speakers on the energy codes for meetings across Canada.
- Conducted a national survey on consumer attitudes to regulating energy efficiency in new houses. The survey covered 1200 prospective and new home buyers and indicated overwhelming support for energy-efficiency codes. The results will be published in the summer of 1994.
- Assessed energy code training needs of architects, engineers, home builders and building officials. Focus groups indicated that they would require training to use the computer programs associated with the performance path of the energy code.
- Conducted case studies of the impact of the codes on commercial and residential new construction. Paybacks were calculated for commercial buildings built to code in 12 regionally disparate cases. Paybacks ranging from 5 to more than 20 years were calculated depending on the characteristics of the base case construction practice. In the residential sector, the use of National Energy Code prescriptions generated a range of paybacks from 5 to 10 years, depending on fuel costs.

R-2000 Home Program

Purpose

To increase the energy efficiency of new homes.

Achievements in 1993-94

- There were 1500 R-2000 Homes built during 1993-94, the biggest year to date. More than 8000 R-2000 Homes have

There were 1500

R-2000 Homes built

during 1993-94, the

biggest year to date.

been built since the program started in the early 1980s.

- Established R-2000 programs in Saskatchewan and Alberta, making the program operational in all provinces.
- Added new partners to the program who contributed over \$4 million to its operations. By year-end, more than 30 Canadian private and public organizations were supporting R-2000.
- Trained more than 1000 builders, bringing to more than 7000 the total number of builders trained since the program began.
- Developed a new standard for the program, the first major technical change since the program started. The new standard, to begin in April 1995, is 15 per cent more energy efficient and adds several environmental and health features.

Energy Innovators Initiative

Purpose

To encourage corporations, institutions and municipalities to become more energy efficient.

Achievements in 1993-94

- Recruited 82 organizations (representing more than 37 million square metres of commercial floor area) to become Energy Innovators. The total number of Energy Innovators rose to 108.
- Secured an agreement among 12 ally organizations to develop a network to disseminate technical information about energy efficiency. This will incorporate materials from the Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADET). Also, began to develop a strategic plan to market CADET.

Building Information Transfer

Purpose

To provide information that encourages the adoption of energy-efficient products and practices in the building sector.

Achievements in 1993-94

- Supported the organization of the fourth "Gala Energia" in Montreal, which recognizes technological innovations in the province of Quebec. In 1993-94, the jury presented awards in the following categories: buildings, environment, product suppliers, industry, municipalities, student projects and transportation.
- Provided advice and assistance in developing a business plan for the Canadian Window and Door Manufacturers Association.
- Helped to promote the new window certification and labelling program of the Canadian Window and Door Manufacturers Association. This program will provide consumers with certified information on the energy performance of windows and doors.
- Participated in an industry-led committee investigating building labelling for houses in Canada and completed a study on receptiveness to building labelling in the commercial building sector.
- In seeking to define an appropriate role for NRCan to facilitate energy retrofits in the residential sector:
 - Held a national workshop for representatives of the energy retrofit industry to discuss possible ways of encouraging homeowners to increase the energy efficiency of their homes.
 - Launched a Renovation Demonstration project in collaboration with the Canada Mortgage and Housing Corporation to demonstrate what is possible when upgrading an older home to modern energy-efficiency and environmental standards.
 - Began to examine the option of home energy rating systems, similar to EnerGuide, to rate the comparative energy efficiency of residential dwellings.

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*The new window
certification and
labelling program
will provide
consumers with
certified information
on the energy
performance of
windows and doors.*

Federal Industrial Boiler Program

Purpose

To assist in the development and use of clean, energy-efficient combustion technologies in federally owned boilers.

Achievements in 1993-94

- Managed heating plant retrofit projects for improved energy efficiency and reduced nitrogen oxide (NO_x) emissions at several Canadian Forces bases (CFBs):
 - Installed a new summer boiler at CFB Gander.
 - Wrote specifications for a heating plant retrofit at CFB Goose Bay that include new combustion controls and metering on five boilers, and new steam-flow metering on two electric boilers. Energy savings are expected to be 3 per cent and NO_x emissions are expected to be reduced by 30 per cent.
 - Wrote specifications for a plant retrofit project at CFB Cold Lake that include combustion controls, complete metering and low NO_x burners.
- Managed a project for Agriculture and Agri-Food Canada for the supply and installation of a cogeneration system and new boiler room equipment at the department's research centre in Vineland, Ontario.
- Completed site-specific services for clients: five non-destructive examination surveys (such as x-rays and ultrasonic testing); six retrofit surveys; three cogeneration feasibility studies; and three life-cycle costing studies.

Buildings Energy Technology Advancement Plan

The Buildings Energy Technology Advancement (BETA) Plan is an integrated set of programs dedicated to developing energy-efficient technologies for residential and commercial buildings in Canada. Through the BETA Plan, CANMET brings together governments, industry and universities to develop a new generation of buildings technology that would reduce the

energy consumption of Canadian buildings by 50 per cent. The plan deals with new, reconstructed and renovated building stock.

BETA Plan — Residential

Purpose

To assist in the development and commercialization of energy-efficient technologies for residential buildings.

Achievements in 1993-94

- Nine Advanced Houses — designed to use half the energy of an R-2000 home — were built and another, in Prince Edward Island, was nearing completion. Five were sold, and four were open to the public. All 10 are expected to reach their target for energy consumption. The Advanced Houses Program attracted considerable media coverage, including the following:
 - *Popular Science* magazine ran a full-colour, six-page feature on the Advanced Houses;
 - the Waterloo Region Green Home was the subject of a paperback book entitled *Green Home: Planning and Building the Environmentally Advanced House*;
 - the P.E.I. Advanced House was featured on *Street Cents*, a national children's television program; and
 - all houses attracted local media coverage, and some were profiled in publications such as *The Financial Post*, *Canadian Architect* and *Daily Commercial News*.
- A variety of innovative products based on Advanced House technologies moved to the market, including:
 - six new high-performance windows specifically designed for Advanced Houses; and
 - an "Enviro Pack" based on several Advanced House technologies being offered by the builder of the Innova Advanced House in Kanata, Ontario, as an option for all its houses.
- Organized seven Advanced House workshops for building and professional groups in Canada and the United States, which accelerated the deployment of Advanced House technologies. Many

Through the BETA Plan, CANMET brings together governments, industry and universities to develop a new generation of buildings technology that would reduce the energy consumption of Canadian buildings by 50 per cent.

members of the housing industry have expressed an interest in retaining the Advanced House performance targets for "state-of-the-art" builders.

- Held the Innovative Housing '93 conference in Vancouver, in partnership with the Canada Mortgage and Housing Corporation, and with support from the National Research Council, Canadian Home Builders' Association and International Energy Agency. The conference attracted more than 650 delegates from 28 countries, and established Canada as a world leader in Advanced Houses technologies. All 10 Advanced Houses were featured in a special display, and nearly 400 delegates toured the B.C. Advanced House. In conjunction with the conference, NRCan held a special Canada-Japan R&D workshop attended by more than 75 housing experts from both countries. Workshop participants identified key R&D needs and developed plans to meet them.
- Enhanced the HOT2000 building energy analysis computer program for the housing industry. HOT2000 is sold by the Canadian Home Builders' Association under licence from CANMET in Canada and the United States. The program will be used to confirm compliance with the new *National Energy Code for Buildings* and is now used the same way for the R-2000 Program.

BETA Plan — Commercial

Purpose

To support the commercial building industry's efforts to develop, commercialize and adopt energy-efficient and environmentally responsible technologies.

Achievements in 1993-94

- Completed technical requirements to guide designers in the pilot project phase of CANMET's C-2000 Advanced Commercial Buildings Program, co-funded by NRCan's Energy Sector, the Canada Mortgage and Housing Corporation, Ontario Hydro and the Ontario Ministry of Energy and

Environment. Developed criteria for several key performance areas, including energy efficiency, environmental impact, occupant comfort, functionality, adaptability and longevity.

- Issued a call for Expressions of Interest in the C-2000 Program. A committee of three CANMET staff and two industry experts selected the following projects to proceed to the concept design phase:
 - a two-building office project in Richmond, British Columbia (proposed by Bunting Coady Architects and Bentall Development Inc.);
 - a new municipal office building for the Town of Banff, Alberta (the Town of Banff and TransAlta);
 - a small two-storey office building in Waterloo, Ontario (Enermodal Engineering Limited); and
 - the retrofit of an office building in Halifax, Nova Scotia (Rose Technology Group and Nova Scotia Power).
- Launched, in partnership with the Royal Architectural Institute of Canada, a newsletter focusing on R&D for large buildings. The *Advanced Buildings Newsletter* covers a broad range of news, events and issues related to advanced buildings. The first three issues were distributed in Canada, the United States and Europe.
- Launched the IDEAS Challenge, a national competition to improve the design and construction of high-rise apartment buildings. Sponsored jointly by CANMET and the Canada Mortgage and Housing Corporation, the challenge offers more than \$225 000 to teams of architects, engineers, building scientists and developers to produce innovative designs for residential buildings of five storeys or more.
- Began negotiations to form the Canadian Consortium for Building Energy Compliance Software. The consortium will jointly develop and support energy compliance software to satisfy the requirements for the 1995 *National Energy Code for Buildings*, utility demand-side management programs, and building research, analysis and design.

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The IDEAS challenge encourages teams of architects, engineers, building scientists and developers to produce innovative designs for residential buildings of five storeys or more.

BETA Plan — Passive Solar

Purpose

To develop, commercialize and encourage the adoption of high-performance window technologies, advanced window R&D, daylighting and commercial building applications, and systems integration to optimize solar energy gains for residential and commercial buildings.

Achievements in 1993-94

- Completed the development of an energy rating (ER) system for windows, which will form the basis for window certification and labelling.
- Co-funded and participated in the development of standards for window installation, door energy performance and wall energy performance, to complement the new A440.2 standard for window energy performance.
- Combined versions of CANMET's Vision and Frame software to provide window manufacturers with the best performance design capability in the world. With the combined software, manufacturers can simulate energy performance and condensation resistance without expensive product testing. CANMET licensed the software in Europe to Nutek, the Swedish government's energy efficiency board, and delivered a four-day training course in Sweden on the use of the software for design and rating purposes.
- Produced the fact sheets "Simulating Energy Performance" and "Energy-Saving Windows" to provide up-to-date information on new window technologies and design tools. Based on these fact sheets, NRCan developed an R-2000 window fact sheet and revised the guide for buying energy-efficient windows.

Heat Management Program

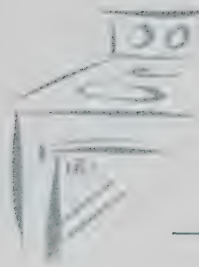
Purpose

To help Canadian companies, manufacturers and energy users develop, commercialize or acquire advanced heat management technologies.

Achievements in 1993-94

- Completed the first phase of a five-year project to develop an energy-efficient, gas-fired absorption heat pump for heating and cooling small commercial buildings. This unit uses no freon and could be a durable replacement option for conventional compressor-driven technology around the world. CANMET's Energy Diversification Research Laboratory's involvement is part of an international R&D consortium involving Canadian gas utilities.
- Initiated a four-year applied research project to develop a low-cost, reliable chemical heat pump in partnership with a Canadian dairy producer. Such technology would allow the company to reduce its operating costs, generate substantial energy savings and meet its energy storage requirements.
- Launched a two-year project with a large Canadian appliance manufacturer and distributor to develop a new generation of high-performance electrical and gas-fired clothes dryers. These dryers are to exceed by 15 per cent the 1995 Canadian and U.S. energy-efficiency standards.
- Completed a joint project with a Canadian manufacturer of ventilation and heat recovery systems to incorporate an innovative humidity control method into a heat-recuperating ventilator. With the assistance of the Energy Diversification Research Laboratory, the company identified the most promising technology for meeting its short-term business goals. Further R&D work was initiated on novel materials that might be used in a more efficient product line.
- Conducted a feasibility study on the technical and commercial viability of a combined energy storage unit and residential heat pump. A Canadian heat pump manufacturer commissioned the Energy Diversification Research Laboratory to do the study. A follow-up R&D project is under way that could result in a product ready for the market.

NRCan completed the development of an energy rating system for windows, which will form the basis for window certification and labelling.



Chapter Four Equipment

Equipment Energy Use

A building can be made more energy efficient by improving the efficiency of its equipment (e.g., furnaces and air conditioners) and how the occupants operate and maintain equipment.

Examples of energy-using equipment are:

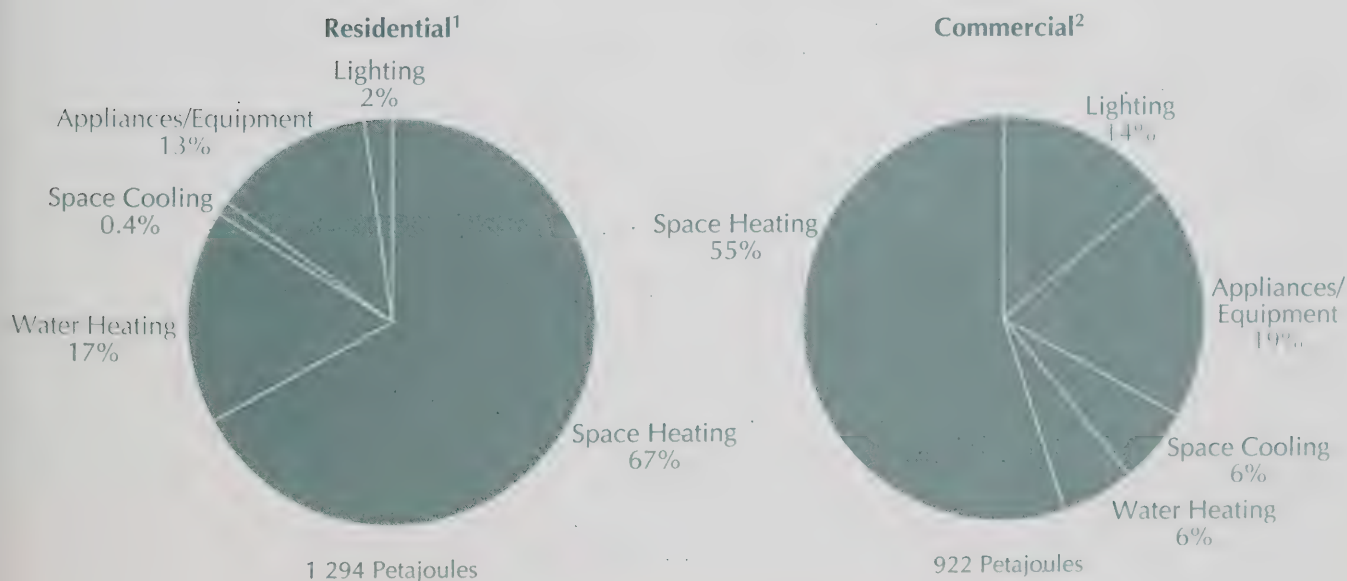
- household appliances (the six major ones are refrigerators, freezers, dishwashers, ranges, clothes washers and clothes dryers);
- water heaters;
- lighting fixtures (including lamps and ballasts);
- equipment for space heating and cooling;
- commercial refrigeration units, such as those used in supermarkets; and

- motors, such as those used in the industrial sector.

Figure 4.1 provides a breakdown, by equipment category, of energy use in the residential and commercial sectors. Space heating accounts for the largest share of energy use in both sectors (about 67 per cent in the residential sector and about 55 per cent in the commercial sector).

In the residential sector, water heating accounts for the second-largest share (17 per cent) of energy use, followed by appliances (13 per cent). Space cooling and lighting account for only a tiny portion of residential energy use.

Figure 4.1
Residential and Commercial Energy Use by End Use, 1992



1 - Excludes farm motive use.

2 - Excludes aviation fuels, diesel fuel oil and motor gasoline.

Sources: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.

Natural Resources Canada, Residential End Use Model.

Natural Resources Canada, Commercial End Use Model.

In the commercial sector, appliances (19 per cent) and lighting (14 per cent) are the second- and third-largest energy end uses. Water heating and space cooling together account for only 12 per cent of commercial energy use.

Efficiency Standards for Equipment

Purpose

To eliminate inefficient equipment from the Canadian market by establishing national energy-efficiency standards for equipment.

Achievements in 1993-94

- Published for comment the first regulations under the *Energy Efficiency Act*, setting minimum energy-efficiency standards for 22 products.¹
- Co-sponsored a National Round Table on Energy-Efficiency Standards and Labelling to develop a process for establishing national minimum energy-efficiency levels and criteria for ranking products to be regulated. Draft documents setting out NRCan's approach to consultation and analysis in developing energy-efficiency regulations were tabled.
- Funded the development or revision of efficiency standards for several products, including electric ranges, electric water heaters, refrigerated display cabinets and electric motors.
- Funded studies to determine the feasibility of establishing minimum energy-efficiency standards for residential exhaust fans, small motors and residential gas appliances.
- Conducted energy-efficiency testing of several products to assess their compliance with proposed standards and the effectiveness of verification programs. The results are being assessed.

EnerGuide

Purpose

To encourage consumers to purchase energy-efficient equipment by providing them with information on the product's energy efficiency.

Achievements in 1993-94

- Published for comment the first regulations under the *Energy Efficiency Act* requiring EnerGuide energy consumption labelling on prescribed products.²
- Implemented a voluntary labelling program for the prescribed products before the first regulations were to come into effect. Industry adopted the new EnerGuide label in many cases.
- Initiated studies to determine the use of the EnerGuide label under a voluntary labelling program to establish a benchmark for assessing changes in compliance after the regulations are in force.
- Reviewed the role and management of the EnerGuide Committee to enhance the contribution of this advisory group. Stakeholders responded positively and a new mandate and operating procedures are being developed.
- In partnership with Ontario Hydro, began a program to train retail sales staff in Ontario on how to use the EnerGuide label to help customers decide what to buy.

NRCan published for comment the first regulations under the Energy Efficiency Act.

¹ The 22 products are clothes dryers, clothes washers, dishwashers, electric ranges, electric water heaters, fluorescent lamp ballasts, freezers, furnaces, gas ranges, gas water heaters, ground or water source heat pumps, integrated over/under washer-dryers, internal water loop heat pumps, motors, oil-fired water heaters, refrigerators, combination refrigerator-freezers, room air conditioners, single-package central air conditioners, single-package heat pumps, split-system central air conditioners, and split-system heat pumps.

² The prescribed products are clothes dryers, clothes washers, dishwashers, electric ranges, freezers, integrated over/under washer-dryers, refrigerators, combination refrigerator-freezers and room air conditioners.



Chapter Five Industry

Industrial Energy Use

The Canadian industrial sector includes manufacturing, mining and forestry activities. Industrial energy use is composed of the energy required by the process-specific technologies within each industry, such as a pulp refiner, a cement kiln or a blast furnace, and all energy needed for service of auxiliary devices. Such applications include steam generation and pumping or compression. Other industrial uses include lighting, heating, ventilation and air conditioning. In 1992 industrial energy use amounted to 2384 PJ or 35 per cent of Canada's total secondary energy use.

Energy use is concentrated in a few industries, as shown in Table 5.1. Pulp and paper, iron and steel, mining, and chemicals account for almost two thirds of industrial energy use.

Figure 5.1 shows secondary energy use by energy type in the largest energy-consuming industries. The three major energy sources used by industry are electricity, natural gas and refined petroleum products. The pulp and paper industry also consumes large amounts of hog fuel¹ and spent pulping liquor,² while the iron and steel industry is a significant consumer of coking coal and coke oven gas. Table 5.2 indicates how energy's importance varies significantly from industry to industry.

¹ Hog fuel consists of pulverized bark, shavings, sawdust and low-grade lumber rejects from the operation of pulp mills, saw mills and plywood mills.

² Spent pulping liquor is a substance primarily made up of lignin, other wood constituents and chemicals that are byproducts of the manufacture of chemical pulp. It can be used in a boiler to produce steam or electricity.

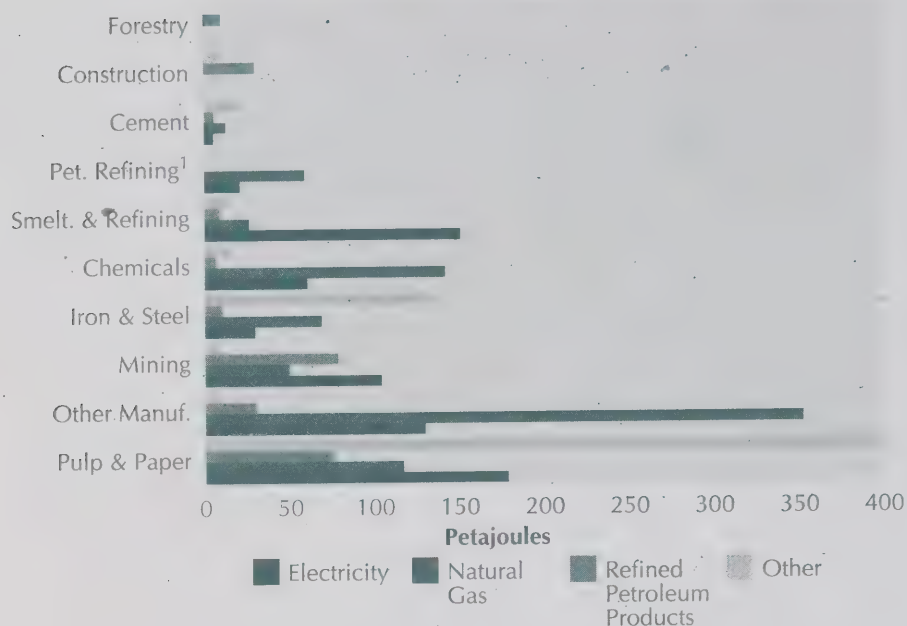
Table 5.1
Industrial Energy Use by Sector, 1992

Industry	Petajoules	Per cent
Pulp and paper	770	32
Iron and steel mining	247	10
Mining	244	10
Chemicals	225	10
Smelting and refining	201	8
Petroleum refining ¹	81	3
Cement	47	2
Construction	39	2
Forestry	10	1
Other manufacturing	520	22
TOTAL	2 384	100

1—In accordance with Statistics Canada's definition of the industrial sector, producers' consumption of non-purchased petroleum products is not reported as industrial sector final demand. Including this consumption would result in petroleum refining energy consumption of approximately 320 petajoules.

Source: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada," Cat. No. 57-003, 1992-IV.

Figure 5.1
Industrial Secondary Energy Use by Energy Type, 1992



1 - In accordance with Statistics Canada's definition of the industrial sector, producers' consumption of non-purchased petroleum products is not reported as industrial sector final demand. Including this consumption would result in petroleum refining energy consumption of approximately 320 petajoules.

Source: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada,"
Cat. No. 57-003, 1992-IV.

Table 5.2
*The Importance of Energy Purchases in
Selected Industries, 1991*

Industry	ENERGY PURCHASES AS A SHARE OF:	
	Total production costs (per cent)	Value of shipments (per cent)
Cement	36.0	16.3
Chemicals	14.0	9.2
Smelting and refining	13.8	10.1
Pulp and paper	12.0	9.8
Iron and steel	9.3	7.6
Petroleum refining	2.0	1.9
Other manufacturing	2.2	1.6

Source: Statistics Canada, "Manufacturing Industries of Canada: National and Provincial Areas, 1991,"
Cat. No. 31-203.

Figure 5.2 ranks the major energy-consuming industries by energy intensity (i.e., energy use per dollar of output). The figure shows that the largest energy users are not necessarily the most energy-intensive.

Industrial Energy Efficiency

Purpose

To increase the efficiency of energy use in goods-producing industries.

Achievements in 1993-94

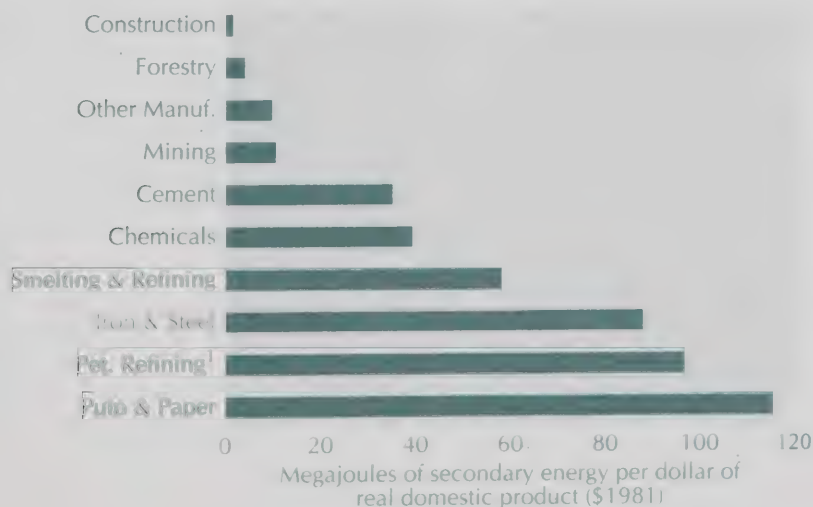
- Convened the inaugural meeting of the Minister's Advisory Council on Industrial Energy Efficiency, which was established to revitalize, and provide direction to the Canadian Industry Program for Energy Conservation (CIPEC). At the meeting, the Minister challenged industry representatives to voluntarily establish energy-efficiency improvement targets.
- Established a Policy Board under CIPEC comprising chief executive officers and

association executives from participating industries. The board, which sets CIPEC's overall direction for increasing energy efficiency in Canadian industry, held its first meeting early in 1994.

- Undertook a preliminary overview of industry's ability to stabilize CO₂ emissions through energy-efficiency improvements. The study provided useful information for industry's energy-efficiency target-setting work to be undertaken in 1994-95.
- Established task force working groups for 8 of the 10 industry sectors. Each working group provides information and expertise on energy issues and develops energy-efficiency targets and action plans for its sector.
- Examined the present use of energy performance contracting in the industrial sector.
- Initiated a pilot program in the plastics sector to develop an energy-efficiency training program for plastics companies.

The Minister
challenged industry
representatives to
voluntarily establish
energy-efficiency
improvement targets.

Figure 5.2
Industrial Energy Intensity by Sector, 1992



1 - In accordance with Statistics Canada's definition of the industrial sector, producers' consumption of non-purchased petroleum products is not reported as industrial sector final demand. Including this consumption would result in an energy intensity of approximately 330 megajoules per dollar.

Sources: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada" Cat. No. 57-003, 1992-IV.
Natural Resources Canada, "Canada's Energy Outlook, 1992-2020," Sept. 1993.

Canadian Energy Management and Environmental Training Program

Purpose

To provide energy users from the industry and building sectors with energy management training programs.

Achievements in 1993-94

- Expanded training partnerships and services under the Canadian Energy Management and Environmental Training Program (CEMET). The program now offers a comprehensive range of training services — from needs analysis to course design and delivery. These developments included:
 - access to specialist training material from industry (e.g., automatic controls from Honeywell Limited and lighting from General Electric Canada Limited);
 - provincial partnerships to expand course content and delivery (e.g., with Ontario's Ministry of Environment and Energy);
 - pilot projects in the commercial buildings and hospitality sectors; and
 - a national network to deliver the Electrical Opportunities Workshop.
- In February 1992, NRCan and Durham College in Oshawa, Ontario jointly funded the CEMET Directorate at Durham College to administer the CEMET program. In 1994, this Directorate became the Canadian Institute for Energy Training, a not-for-profit organization with a continuing responsibility for administering the CEMET program. Under the program, 14 CEMET courses and 7 electrical opportunities workshops were delivered in eight colleges in five provinces to more than 320 students from the buildings, utilities and industrial sectors.
- Participated in the annual conference of the Association of Canadian Community Colleges attended by more than 900 delegates from across Canada. This conference increased awareness of the Energy

Innovators initiative in the college sector, and led to four new colleges joining the CEMET network.

- Contributed to the Canadian Electrical Association's energy-efficiency advisors project. This is developing a skill profile for energy advisors and a database on the availability of energy management courses.

Industry Energy R&D

Purpose

To assist industry in developing products, processes, services and systems to reduce energy use.

Achievements in 1993-94

- Partially funded Zimmark Inc. in developing a way to recover and reuse lubricating oil from diesel locomotive engines under stringent quality standards. Canadian National and Canadian Pacific Railways use this system to recycle more than a million litres of crankcase oil per year. This system is also being used by five U.S. railroads and in three Asian countries.
- Provided co-funding to Stackpole Limited of Toronto to become a world leader in the manufacture of high-quality low-cost automotive parts using powder metallurgy (PM). The PM process uses about 30 per cent less energy than other processes such as machining or forging. Stackpole developed an assembly system for the engine of Chrysler's new Neon car over this period. Stackpole is also the sole North American supplier of PM parts to the General Motors Saturn car. The company's PM activities have created 400 jobs.
- Officially opened a radio-frequency/vacuum (RF/V) kiln for drying softwood lumber. The kiln was developed jointly by CANMET, the Council of Forest Industries and other partners. Canada exports \$1.1 billion of forest products to Japan annually and \$800 million to the European Community. Increasingly, these markets want higher-grade lumber in both appearance and performance. Moreover, because of concerns over wood

The Canadian Energy Management and Environmental Training Program now offers a comprehensive range of training services — from needs analysis to course design and delivery.

parasites, some markets are demanding that lumber be pasteurized. The RF/V kiln meets all these needs using a fraction of the energy and in a fraction of the time of conventional kilns.

- Co-funded Trench Electric in the development and successful testing of a prototype Volts Ampere Reactive (VAR) compensator at Monroe Automotive in Owen Sound, Ontario. The power factor compensator helps to reduce the need to generate additional power and maintains power quality by compensating for the amount of reactive current caused by some loads (the reactive current contributes to losses in the transmission and distribution of electric power).

Industry Targeted Program

Purpose

To identify and foster opportunities for energy-efficiency R&D, field trials and technology transfer in the goods-producing industries.

Achievements in 1993-94

- Provided funds to Avenor Inc.'s Dryden Mill to purchase and install a comprehensive, mill-wide energy management system, with co-funding from the Ontario Ministry of Environment and Energy. The mill produces blended kraft pulp and fine paper. This project is a direct result of an earlier assessment of management information systems partly funded by the Industry Targeted Program.
- Funded Lobbe Technologies Ltd. of Regina in its assessment of artificial intelligence systems in the mining and metallurgy, oil and gas, iron and steel, cement, and pulp and paper industries. Artificial intelligence systems can decrease energy use, reduce environmental impacts, improve productivity and product quality, and provide better safety control. B.C. Hydro, Ontario Hydro and Hydro-Québec are also funding this study.
- Provided funding to Galt Forge Limited to develop and evaluate a highly automated energy-efficient heat-treating furnace at its new facility in Paris, Ontario. The

Ontario Ministry of Environment and Energy, Union Gas and Consumers Gas also contributed.

- Co-funded a closely controlled mill trial of Boise Cascade Canada Ltd.'s mill in Fort Frances, Ontario. Ontario Hydro, Norton Canada Inc. and Boise also contributed; the Pulp and Paper Research Institute of Canada and the Canadian Centre for Pulp and Paper in Trois-Rivières, Quebec, also participated. The objective is to accurately measure the improvements to energy efficiency and productivity from using helically grooved pulpstones. The results are expected in June 1994.
- Co-funded a project, conducted by Sandwell Inc. of Montreal, to examine how changes to bleaching systems affect energy consumption, chemical use and related atmospheric emissions over the long term. A report entitled "Chemical Pulp Bleaching: Energy Impact of New and Emerging Technologies" is expected next year. The other stakeholders in this venture were Hydro-Québec, Sterling Pulp Chemicals Ltd., the Canadian Pulp and Paper Association and the Canadian Electrical Association.

Gas Technologies Program

Purpose

To develop advanced natural gas technologies for the commercial and industrial sectors.

Achievements in 1993-94

- Completed a feasibility study for a Canadian manufacturer on improving the performance and reducing the size of a high-efficiency commercial heating ventilation prototype unit. This led to the development of an innovative ventilation concept that could improve efficiency by five to nine per cent.
- Launched, with a Canadian manufacturer and Gas Technology Canada, a research project to develop a natural gas-fired pulsed fluidized-bed dryer for industrial applications.

The radio-frequency/vacuum kiln meets all these needs using a fraction of the energy and in a fraction of the time of conventional kilns.

-
- Began a waste-water treatment R&D project in cooperation with École polytechnique at the Université de Montréal with financial support from Canadian gas utilities, which will use natural gas to reduce the concentration of organic contamination in typical industrial waste water. This process could be an add-on to improve the efficiency of conventional water treatment, or it could replace the expensive process of wet air oxidation.
 - Initiated a project to bring an innovative grain dryer to the pre-commercialization stage in cooperation with Gas Technology Canada and McGill University. The new dryer will be twice as energy-efficient and five times more productive than existing units.

■ ■ ■ ■ ■



Chapter Six Transportation

Introduction

The EAE program includes two types of initiatives dealing with transportation energy use. This chapter describes initiatives to improve transportation energy efficiency, while chapter seven outlines initiatives to increase the use of alternative transportation fuels.

Transportation Energy Use

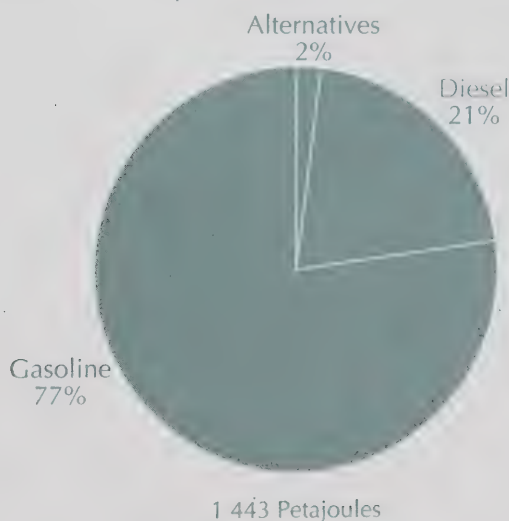
In 1992 the transportation sector — including road, air, marine and rail transportation — used about 27 per cent of total secondary energy, or 1809 PJ. Within the sector, road transportation accounts for about 80 per cent (1443 PJ), with the remaining 20 per cent coming, in descending order, from air, marine

and rail transportation. As shown in Figure 6.1, gasoline accounts for about 77 per cent and diesel fuel for 21 per cent of total energy use in the road segment, while alternative fuels, such as propane and compressed natural gas, account for the remaining two per cent.

Gasoline consumption in the road segment is almost exclusively attributable to light-duty vehicles: cars use 66 per cent and light trucks use about 29 per cent; medium and heavy trucks use only about five per cent (see Figure 6.2). However, heavy trucks account for most road diesel use. Light-duty vehicles continue to use only a small percentage of road diesel.

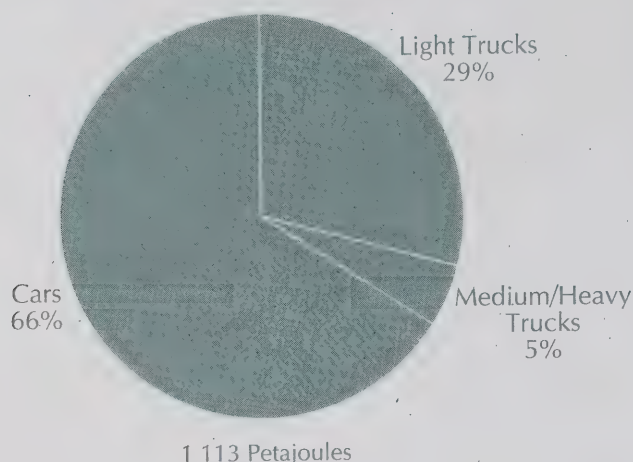
In 1992 the
transportation sector
used about 27 per cent
of total secondary
energy.

Figure 6.1
Road Segment Energy Demand by Fuel, 1992



Sources: Statistics Canada, "Quarterly Report on Energy Supply - Demand in Canada,"
Cat. No. 57-003, 1992-IV.
Natural Resources Canada, Transportation Energy Demand Model.

Figure 6.2
Road Segment Motor Gasoline Demand by Vehicle Type, 1992



Sources: Statistics Canada, "Quarterly Report on Energy Supply – Demand in Canada,"
Cat. No. 57-003, 1992-IV.
Natural Resources Canada, Transportation Energy Demand Model.

Motor Vehicle Fuel Consumption Standards

Purpose

To ensure that new motor vehicles meet or exceed average fuel-efficiency standards and that consumers are aware of fuel-efficiency differences when shopping for a new vehicle.

Achievements in 1993–94

- Carried out a survey on fuel consumption labelling to determine whether manufacturers affix labels on new vehicles and whether dealers leave the labels in place. Results showed that, except for some foreign-made vehicles, the level of compliance by manufacturers is quite high prior to the retail sale. However, the label often does not remain prominently affixed for the consumer to see at the point of sale.
- Distributed about 500 000 copies of the 1994 *Fuel Consumption Guide* with Transport Canada.

Transportation Energy Efficiency

Purpose

To promote energy efficiency in the Canadian transportation sector.

Achievements in 1993–94

- Established a task force to help develop and produce a new driver education module. The module, which will complement existing private and public driver education programs, will help new drivers understand energy-efficient driving practices. The task force, representing the Canada Safety Council, the Canadian Automobile Association, Young Drivers of Canada, Transport Canada, provincial energy departments and the Canadian Petroleum Products Institute, will monitor and advise on the production process.
- Held a fact-finding seminar for fleet managers and equipment suppliers to discuss new ideas and techniques. About 80 fleet managers from central and eastern Canada attended the seminar.

The new driver education module, which will complement existing private and public driver education programs, will help new drivers understand energy-efficient driving practices.

- Developed a train-the-trainer course for the Pro-Trucker Program in British Columbia. During the year, 15 fleet instructors representing about 1500 truck drivers attended the two-day course.
- Reached agreement with three companies to install and test in-vehicle driver-monitoring equipment. The purpose of the demonstrations is to reduce engine idling and engine over-revving and to manage vehicle speeds. In addition, the demonstration will measure driver reaction to the monitoring and the cost-effectiveness of this equipment.
- Reached agreement with a long-haul trucking firm to install and test an auxiliary engine and sleeper heater. The demonstration will measure the effectiveness of diesel-fired cab and engine heaters to decrease engine idling and engine wear.
- Contracted with a long-haul trucking company to have a consultant optimize the fuel efficiency of the fleet by updating existing vehicles, training drivers and optimizing new vehicles. This is a two-year project in partnership with the province of Quebec.

- Completed a project with Ortech International of Mississauga, Ontario, Environment Canada and the Canadian Petroleum Products Institute to correlate the composition of diesel fuel with exhaust emissions. The results will be used to develop future regulations on diesel fuel composition. The report is entitled *Impact of Diesel Fuel Aromatics on Particulate, PAH and Nitro-PAH Emissions*.
- Launched a project with KOR Engineering of Winnipeg to develop a hybrid electric- and human-powered transportation system, with funding by the Environmental Innovation Program, the Province of Manitoba, the City of Winnipeg and I.D. Engineering. This is a zero-emission concept that would require low amounts of energy. It is intended to complement conventional transportation systems in world fairs and parks, among other venues.
- Initiated a cooperative program to investigate the catalytic reduction of diesel NO_x emissions. Participants include CANMET's Energy Research Laboratories, Environment Canada, Ortech International (Mississauga, Ontario), Engine Control Systems Ltd. (Newmarket, Ontario), Perkins Group (United Kingdom), Suncor Inc. (Fort McMurray, Alberta), Husky Oil Ltd. (Calgary, Alberta) and Syncrude Canada Ltd. (Fort McMurray, Alberta).

Transportation Efficiency R&D Program

Purpose

To support the development and commercialization of vehicle technologies that will contribute to reduced fuel consumption and a cleaner environment.

Achievements in 1993-94

- Provided funds to Nisymco Inc. of Dollard-des-Ormeaux, Quebec, to analyze the feasibility of recovering thermal energy from road vehicles. Eventual benefits will be through energy-efficiency gains by effective use of the waste heat from vehicle engines.

This hybrid electric-
and human-powered
transportation system
is a zero-emission
concept that would
require low amounts
of energy.



Chapter Seven

Alternative Energy

Alternative Energy Sources

Alternative energy is generally defined as including renewable sources, such as bio-energy, small hydro, solar, wind, geothermal, tidal energy and photovoltaic conversion systems. In addition, the term covers new transportation fuels (such as ethanol from renewable energy sources) and new applications of conventional energy sources (such as the use of propane and natural gas as automotive fuels, and batteries in electric vehicles).

Renewable energy, mainly biomass, supplies about five to seven per cent of total primary energy demand in Canada. The pulp and paper industry uses biomass (wood and pulping wastes) for about half its energy requirements, and the residential sector uses wood to meet 7.5 per cent of its energy demand. There are a number of small hydro-electric installations in some provinces, totalling 1540 megawatts of capacity across Canada. Other renewable forms of energy, however, remain in limited use: wind (comprising more than 7.5 megawatts of electrical generation capacity); solar (totalling more than 10 000 hot water systems and 170 commercial and industrial systems); and earth energy.

Alternative transportation fuels (ATFs) currently account for about two per cent of Canadian transportation energy use. Propane and natural gas are used directly in vehicles either converted or manufactured for their use. Propane supplies 1.6 per cent of the Canadian road transport market, with about 160 000 propane vehicles in operation supported by some 5000 public and 2000 private fueling stations. There are about 30 000 natural gas vehicles in operation, supported by 120 public and 80 private refueling stations. There are also 120 natural gas-fueled public transit buses.

The alcohol transportation fuels, methanol and ethanol, can also be used directly in vehicles. At present, however, ethanol is mainly used as an extender in gasoline blends. There are only

about 400 light-duty methanol vehicles in operation. Ethanol blends (10 per cent ethanol) are being marketed in the four western provinces and in Ontario.

Alternative Transportation Fuels

Propane

Purpose

To promote the use of propane as a vehicle fuel.

Achievements in 1993-94

- Provided financial support to Chrysler Canada for the development of a propane concept vehicle (a pre-production model). As a result, Chrysler decided to produce a propane-powered full-sized van for the 1996 model year at its Windsor, Ontario plant.
- Expanded the Newfoundland propane demonstration project by installing additional state-of-the-art propane refueling stations across the island (bringing the total to 29 stations), opening two more conversion centres and converting another 45 vehicles to propane (bringing the total to more than 120 vehicles).

Natural Gas

Purpose

To promote the use of natural gas as a vehicle fuel.

Achievements in 1993-94

- Funded the conversion of approximately 3225 vehicles to natural gas and the purchase of 300 vehicle-refueling appliances.
- Funded 11 natural gas-fueling stations.
- Commissioned Cogem Research Inc. of Montreal to survey the attitudes and experiences of natural gas vehicle users. The reports identified levels of user acceptance and market barriers.

■ ■ ■ ■ ■
*Renewable energy,
mainly biomass,
supplies about five to
seven per cent of total
primary energy
demand in Canada.*

- Funded production, through the Canadian Gas Association, of a series of videos to be used by the natural gas industry to market natural gas as a motor vehicle fuel.
- Provided funding to a study by the Canadian Gas Association on the market potential of natural gas as a fuel in bus operations (e.g., public transit, para-transport, school, shuttle). The study identified market opportunities and technical barriers to the market penetration of natural gas buses.

Methanol

Purpose

To encourage the use of methanol as a transportation fuel.

Achievements in 1993-94

- Provided funding for public access refueling stations in Toronto. Also provided funding for on-site refueling facilities for fleet applications.
- Co-sponsored, with the Canadian Oxygenated Fuels Association, the Methanol Light-Duty Vehicle demonstration project, which led interested private fleets and operators to purchase about 150 methanol passenger cars produced by Ford Motor Company of Canada Limited and Chrysler Canada Ltd.
- Completed a study of the development of a Methanol Fuel Infrastructure Model. The purpose of the model would be to determine how a methanol infrastructure would evolve under various scenarios of vehicle characteristics, fuel availability, taxes and other market development initiatives. The model is being expanded to cover gaseous fuels.

Ethanol

Purpose

To encourage the production and use of ethanol as a transportation fuel, and to further the development of lower-cost ethanol feedstocks.

Achievements in 1993-94

- Completed a study with Sunoco Inc. to evaluate the technical and economic fea-

sibility of the large-scale introduction of ethanol gasoline.

- In association with the National Research Council, continued to conduct an analysis for southern Ontario of the contribution to ground-level ozone from ethanol blending, using a simulation model.

Alternative Transportation Fuels R&D Program

Purpose

To support technology development for ATFs and to remove the technical and institutional barriers to their penetration of the marketplace.

Achievements in 1993-94

- Provided funding and technical assistance to Ballard Power Systems of North Vancouver to launch the world's first fuel-cell-powered, zero-emission transit bus. Phase II of the project was expanded to develop a full-sized bus.
- Provided funding to Alcan International Limited's development of a new lightweight aluminum-alloy, compressed natural-gas storage cylinder. The first 100 cylinders were fabricated from billets cast at Alcan Extrusions in Pickering, Ontario and are being evaluated with respect to certification to ISO and NGV-2 standards. The major auto makers are evaluating the cylinders for use.
- Provided funding and technical advice to Ontario Hydro to evaluate and demonstrate a 200 kW phosphoric acid fuel cell that is powered by natural gas in a commercial building in Toronto. Fuel cells are cleaner and more efficient than conventional thermal generation plants. Other partners include Consumers Gas, the Canadian Electrical Association and the Ontario Ministry of Environment and Energy.
- Helped fund British Columbia Research Inc.'s successful modification of a Caterpillar 3306 engine to use natural gas. This program will help open the diesel-powered truck market to natural gas. B.C. Gas, B.C.

■ ■ ■ ■ ■
The Methanol

Light-Duty Vehicle

demonstration

project led

interested private

fleets and operators

to purchase about

150 methanol

passenger cars.

Science Council and California's South Coast Air Quality Management District also provided funding.

- Launched a project with Inco Limited to test a state-of-the-art electric vehicle (the TEVan), manufactured by Chrysler in Windsor, that uses nickel cadmium batteries with Inco-produced nickel powders. The effects of fast charging on the batteries will be studied using a fast charger designed by Norvik Technologies of Mississauga. NRCan provided technical support and is monitoring the project.
- Served on the steering committee for, and provided funding and technical advice to, GFI Control Systems Inc.'s testing program, which helped to qualify GFI's natural gas fuel-injection system as the "Conversion Kit" Qualified Vehicle Modifier (QVM). The QVM is a program that qualifies car components as meeting Ford's standards such that they can be installed on Ford vehicles and qualify under Ford's warranty programs.
- Provided funding for the development by FIBA Canning Inc. of Markham, Ontario, of a new type of garbage or recyclable collection vehicle using a natural gas-powered hybrid hydrostatic drive system.

Renewable Energy Sources

Renewable Energy Market Assessments

Purpose

To review renewable energy use, resources and commercially available technologies and to establish their potential for meeting energy and environment goals.

Achievements in 1993-94

- Funded a study by Sunoco Inc. of the environmental and economic merits of blending ethanol with gasoline at the refinery rather than in the distribution network.
- Began developing a computer model of the forest biomass fuel resource in Canada and its conversion and marketing, to help analyze options for encouraging its use.

Information and Awareness

Purpose

To expand the use of renewable energy technologies.

Achievements in 1993-94

- Co-funded the annual Solar Energy Society of Canada Inc. conference on renewable energy and conservation attended by about 200 scientists, academics and representatives of the solar industry and federal government.
- Published 150 000 copies of *A Guide to Residential Wood Heating*. This book is distributed free to enhance the safety of wood-burning in Canadian homes.

Canada - Prince Edward Island Cooperation Agreement on Alternative Energy Development and Energy Efficiency

Purpose

To enhance energy security and energy-use efficiency in Prince Edward Island; to increase production of renewable energy from local resources; to stimulate local employment, entrepreneurial and industrial opportunities in wood chip harvesting and transportation; and to promote biomass heating system fabrication and engineering.

Achievements in 1993-94

- Co-funded six additional small biomass projects in the agricultural sector, bringing to 21 the number of agricultural biomass projects under this agreement.
- Co-funded, with the P.E.I. Energy Corporation, the Prince Edward Home, a heating station that adds capacity to the Charlottetown area district heating system.
- Completed and tested locally the Retrofit Energy Analysis Program (REAP) lighting energy-audit software program.
- Partially funded a load management study for the Maritime Electric Company Ltd. to develop demand-side management programs for the province.

Renewable Energy Technologies Program

Purpose

To support Canadian industry in developing and commercializing advanced renewable energy technologies.

Achievements 1993-94

- Provided financial support and technical advice to Lafarge Canada to develop a system to co-fire waste tires with conventional fuels in its cement kilns. January field trials showed emission levels of NO_x and hydrocarbons 10-15 per cent lower than with oil alone, with no effect on cement quality.
- Completed the first phase of "PV for the North," a five-year joint undertaking by the Energy Diversification Research Laboratory and the Science Institute of the Northwest Territories aimed at increasing the penetration of photovoltaic technologies in Canada's North. The first phase identified possible applications for photovoltaics in the North, such as remote telecommunications and power grid-connected applications. The technology will be deployed in the second phase.
- Signed an agreement with Asea Brown Boveri Inc. of St-Laurent, Quebec, for joint work on a fluidized bed pilot plant to be installed at the Avenor Inc. paper mill in Thunder Bay. This technology allows furnaces to be retrofitted to use biomass fuels, including recycled wastes and sludges.
- Completed a hydro turbine test facility at Laval University and began testing a 120 kW "S" turbine developed by Laval University. As owner of the turbine technology, NRCan helped fund the laboratory and coordinate the work so that the small hydro industry could use the facility on a cost-recovery basis.
- Co-financed the development by Dirk and Price Engineering Ltd. of Kelowna, British Columbia, of a programmable logic controller for photovoltaic-powered distress phones. This led to the commercialization of

Canadian-made distress phones that cost 60 per cent less than foreign products. Okanagan University College in British Columbia installed an on-campus distress phone with this controller.

- Funded the development and performance monitoring of Conserva Engineering Inc.'s perforated solarwall. General Motors provided funds to have it installed in its Oshawa battery plant. The perforated solarwall demonstrated an average solar energy collection efficiency of more than 70 per cent. This helped the company obtain orders for several new installations in Canada, the United States, Germany, Italy and Southeast Asia.
- Completed a study of the commercial potential of Canadian thin-film photovoltaic technologies. The study showed that an innovative technology demonstrated at the laboratory scale could help Canadian companies capture a significant share of this multibillion dollar global business. The development of the technology will be pursued in collaboration with the private sector.
- Completed a prefeasibility study to evaluate the technical and economic viability of hybrid photovoltaic, wind and diesel power supply systems for remote areas of Canada. Parks Canada decided to convert its Ellesmere Island station to such a system next year.
- Completed an in-house technical and economic feasibility study of solar heating for aquaculture applications. This showed that solar heating for fish hatcheries is potentially more cost-effective than conventional heating sources, including natural gas. Research is under way to verify the fish growth models used in the study and to determine what effect temperature variations would have on fish growth. Successful development of this technology would increase the competitiveness of the aquaculture industry and expand niche markets for the solar industry.
- Completed in-house pilot testing of a CANMET-developed hydrotreating technology for the production of cetane

■ ■ ■ ■

*The perforated
solarwall
demonstrated an
average solar energy
collection efficiency
more than 70 per cent*

enhancers from biomass-derived oils. Based on the pilot's successful results, and with technical advice from CANMET, Arbokem Inc. of Vancouver completed an engineering design study for a demonstration cetane plant (250 tonnes/year) to be located in Prince George, B.C. The plant would convert tall oil (a byproduct of kraft pulping) into a cetane booster (used for cleaner diesel-fuel combustion). The technology would benefit the pulp and paper industry by providing a value-added product, increasing the output and efficiencies of the pulp mills, and ridding the mills of an environmental disposal problem.

- In partnership with MacMillan Bloedel and MPB Technologies of Montreal, provided financial assistance and technical advice to successful field trials of infrared furnace temperature monitoring systems for wood-fired boilers. These tests proved that the monitoring of the combustion gases, particulates and temperatures enabled adjustments to be made to the combustion environment,

which improved boiler efficiencies and reduced emissions. As a result, commercial applications are being pursued in the forestry, mineral and metal industries.

- Assisted Ensyn Technologies Inc. with several projects to increase the commercial application of its rapid thermal processing (RTP) technology. Ensyn's RTP technology uses fast pyrolysis to convert wood and other forms of biomass to bio-oil for heat and power generation. CANMET helped to secure a financial commitment from the European Union to undertake a \$2 million power plant demonstration project in partnership with the Italian electric utility ENEL. CANMET also coordinated the initial phases of two international cost-shared projects that evaluated the potential for bio-oil use in diesel and gas turbine engines. Because of the positive results of these evaluations, both projects are proceeding to the demonstration stage with an expanded international consortium.

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Canada

Gouvernement
Publications

*Report to Parliament
on the Administration
and Enforcement
of the*

Energy Efficiency Act

1994-95



Canada

His Excellency the Right Honourable Roméo LeBlanc,
P.C., C.C., C.M.M., C.D., Q.C.
Governor General of Canada
and Commander-in-Chief

Your Excellency:

I have the honour to present the *Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act* for the fiscal year ending March 31, 1995, in accordance with section 36 of the act.

Respectfully submitted,

A handwritten signature in dark ink, reading "A. Anne McLellan". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

A. Anne McLellan
Minister of Natural Resources

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Loi sur l'efficacité énergétique, 1994-1995*

Minister's Foreword



During the last year, the federal government conducted the most comprehensive review of federal government activities ever undertaken. It has been a catalyst for renewal, part of what must be a continuous effort to "get government right" while making it more affordable for Canadians.

The review confirmed the importance of the Natural Resources Canada (NRCan) programs that support improvements in energy efficiency and the use of alternative energy. The federal budget stated that NRCan "will reorient energy policy from a traditional focus on supply to an increased emphasis on efficiency and alternative energy sources, the environment and sustainable development." Energy efficiency and alternative energy initiatives will be important to fulfilling our international commitment on climate change to stabilize greenhouse gas emissions to 1990 levels by the year 2000.

At NRCan, we are responding to the risk of climate change through a variety of initiatives. This document reports on NRCan activities during 1994-95 to promote energy efficiency and the use of alternative energy in all sectors of the economy, under the authority of the *Energy Efficiency Act*. The year marked progress on several fronts, for example:

- on the regulatory front —
 - the coming into force on February 3, 1995, of the first federal regulations under the *Energy Efficiency Act*, and
 - publication in April 1994 of the first draft of the national energy codes for buildings and houses, developed with the federal government and other partners' financial support;
- under our voluntary initiatives —
 - an increase in the number of Energy Innovators from 125 to 200 Canadian corporations, institutions and municipalities, representing 50 million square metres of floor space,
 - the construction of almost 1000 R-2000 homes, and
 - the launch of the Auto\$mart Program, aimed at reducing emissions from vehicles through information, training and exhortation; and
- in research and development —
 - the beginning of a three-year project to perform energy audits for 20 foundries per year across Canada, using a propane-powered Mobile Foundry Laboratory, and
 - the installation of energy-saving and emission-reduction systems at several federal government heating plants, under CANMET's Federal Industrial Boiler Program.

NRCan's Efficiency and Alternative Energy (EAE) Program — the subject of this report — is a key component of Canada's National Action Program on Climate Change (NAPCC). The NAPCC also includes a new Voluntary Challenge and Registry Program. This program will broaden awareness of the need to take action and report on the plans and accomplishments of organizations that reduce their greenhouse gas emissions.

Voluntary measures can be very effective provided we take responsibility for our energy use. This means learning more about the opportunities to better manage our demand for energy, and changing our energy-using habits. Thanks to advances in energy-efficient technologies, this can be done without sacrificing the benefits we enjoy from energy use. NRCan's R&D programs, including those funded by EAE and the Program of Energy Research and Development, help to ensure a continuing flow of new technologies.

Taking responsibility for our energy use is an act of leadership. For my part, I am committed to making my department the most energy-efficient department in the federal government. My federal, provincial and municipal colleagues are responding to my invitation to use the tools NRCan has developed to reduce energy use in public buildings. The Federal Buildings Initiative (FBI) has become the model for many provincial, municipal and institutional energy-efficiency initiatives. All three levels of government are actively working together to accelerate the replication of the FBI from coast to coast.

At the federal level, under the FBI, all custodian departments have agreed to develop long-term energy-management plans and all have some energy-efficiency projects in progress. These activities will not only save energy and reduce environmental impacts, but they will also help the federal government save money.

We are also working with other departments to implement the Federal Fleet Initiative. Our goal is to reduce vehicle emissions in federal government departments by 30 per cent by the year 2000. An important part of this initiative will be the increased use of alternative fuels where cost-effective and operationally feasible. This alternative fuels policy was endorsed by the federal government in the passage of the *Alternative Fuels Act*.

I am asking all Canadians to meet the challenge of climate change by taking advantage of the opportunities to improve our use of energy. To be successful, NRCan's EAE program initiatives require partners — partners in government, partners in industry, partners in every home in Canada. We all use energy, and we can influence the decisions of large energy users. Together, we can create the right climate for sustainable energy use.

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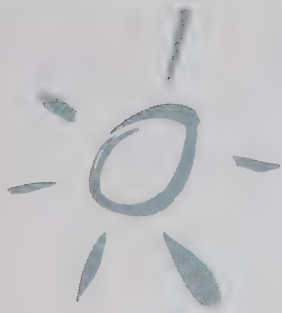
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Policy Context and Regulations

Overview

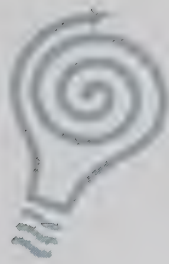
Natural Resources Canada (NRCan) supports energy efficiency and alternative energy (EAE) to help meet the government's energy, environmental and economic policy objectives. The federal government's *Energy Efficiency Act* gives the Minister of Natural Resources the authority to promote EAE, and requires the Minister to table before Parliament an annual report on the administration and enforcement of the act in the previous fiscal year. This third *Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act* covers activities to promote EAE during the fiscal year ending March 31, 1995.

To put the department's efforts in context, chapter one describes:

- the importance of energy to Canadians;
- the federal approach to EAE; and
- NRCan's strategy to encourage Canadians to invest in greater EAE.

Chapter two outlines the regulation-making powers under the act, the first energy-efficiency and labelling regulations, the consultation process, compliance provisions, and work under way to expand the coverage of the regulations. Chapters three through nine describe NRCan's EAE programs, which are managed by the Energy Demand Branch and the Energy Supply Branch of the Energy Sector, the Energy Technology Branch and the Mineral Technology Branch of the Canada Centre for Mineral and Energy Technology (CANMET), and the Science and Sustainable Development Directorate, Canadian Forest Service.

Natural Resources
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government's energy,
environmental and
economic policy
objectives.



Chapter One

Introduction

Energy Use in Canada

Canadians are fortunate. We enjoy an abundance of energy and have access to a variety of energy sources. Our high standard of living is attributable in part to a reliable supply of energy at reasonable cost.

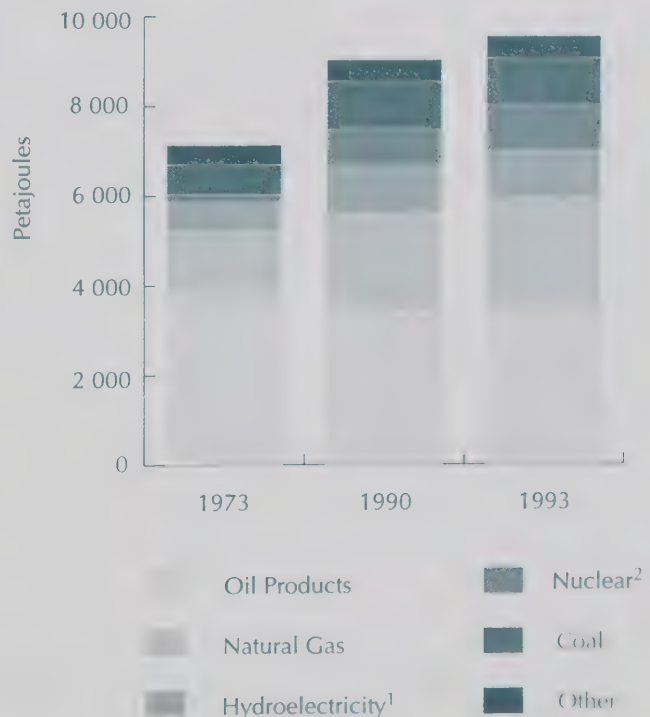
This advantage led to the development of industries with a particularly strong demand for energy. It also helped Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. As a result, Canada tends to consume more energy per capita than other countries.

The importance of energy to Canadians and to the Canadian economy is evident in its direct contribution to economic activity. For example, energy makes up about 7 per cent of total Canadian investment. The economic importance of energy varies from region to region but, wherever it is produced or used, it is fundamental to our way of life. Energy demand will continue to respond to the growth of the Canadian population and economy, moderated by improvements in the efficiency with which we use energy.

Primary energy use is the total requirement for all uses of energy. This includes energy used by consumers, energy used to transform energy from one form to another, and energy used by suppliers to deliver energy to the market. Primary energy use in Canada today reflects changes

over the past two to three decades in energy-consuming equipment and buildings, and in the behaviour of energy users. Between 1973 and 1993, primary energy use increased by 34 per cent, from 7143 petajoules (PJ) to 9578 PJ (see Figure 1.1). The share held by oil fell from 53 per cent to 36 per cent, while nuclear energy's share increased from 2 per cent to 11 per cent. Natural gas, coal and hydroelectricity also increased their share of primary energy use.

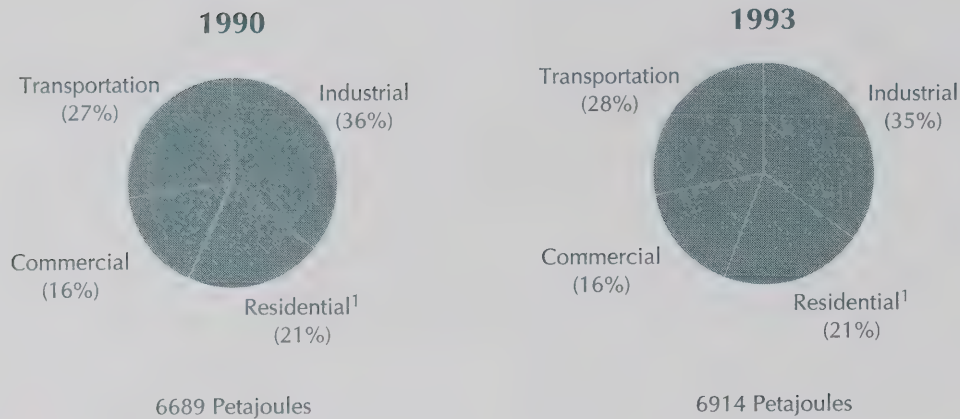
Figure 1.1
Primary Energy Demand by Fuel,
1973, 1990 and 1993



1. Conversion factor: 3.6 kilojoules per watt-hour.
2. Conversion factor: 11.564 kilojoules per watt-hour.

Source: Statistics Canada, NRCan, *Energy Statistics Handbook*, Cat. no. 57-601, March 1995.

Figure 1.2
Secondary Energy Use by Sector



1. Includes farm motive use.

Source: Statistics Canada, "Quarterly Report on Energy Supply-Demand in Canada,"
Cat. no. 57-003, 1993-IV.

These changes occurred in response to economic and institutional factors. In particular, they reflect the impact of two major oil price shocks and of government programs to promote energy conservation and oil substitution. These events also influenced energy intensity in Canada. Energy intensity is the amount of energy used per unit of real domestic product, and it is measured differently for different energy sectors. In the 1970s and early 1980s, energy intensity decreased as energy prices increased and government EAE programs were established. Energy prices peaked in 1984, and energy prices and intensity have remained fairly stable since 1987.

Secondary energy use refers to the energy used by final consumers in the residential, commercial, industrial and transportation sectors. It accounted for 72 per cent of primary energy use in Canada in 1993, and grew from 6689 PJ in 1990 to 6914 PJ in 1993. Figure 1.2 shows each sector's share of total secondary energy use in those two years. The industrial sector has been the most significant energy user of the four,

accounting for more than one third of total secondary energy use. The transportation sector has been and continues to be the second-largest energy user, followed by the residential (including farms) and commercial sectors.

The Federal Approach to EAE

Toward the end of the 1980s, countries around the world began to respond to concerns that atmospheric emissions from the use of fossil fuels could contribute to climate change. This led Canada and more than 150 other countries to sign the United Nations' *Framework Convention on Climate Change* in 1992. NRCan (then called Energy, Mines and Resources Canada) renewed and expanded its support for EAE, building on its long experience in designing and managing EAE programs. This program expansion took into account:

- the need for flexibility as programs mature and we improve our understanding of the implications of EAE opportunities and of global warming;

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- international competitiveness and trade commitments; and
- other policy objectives, especially fiscal restraint.

The EAE program supports increases in energy efficiency and the use of alternative energy on an economic basis. It encourages investment in corporate and consumer EAE opportunities and seeks to engage all sectors of the economy and the public in rethinking and improving their use of energy. The program uses a variety of policy instruments, such as information, voluntary programs, R&D and regulation. In all cases, it emphasizes partnership with stakeholders, such as provincial governments, private sector companies and non-governmental organizations. In this manner, the program helps the demand side of the energy market move toward more energy-efficient capital stock, production processes and operating practices, without reducing the level of service or comfort that energy provides. On the supply side of the energy market, the program ensures that Canada participates in the development of technology for tapping renewable sources of energy and alternative transportation fuels.

NRCan's EAE program also provides a foundation for longer-term processes that can respond to evolving environmental and economic development priorities. Through the program, the department has enhanced its statutory authority, improved its data-gathering and analysis capabilities, and forged stronger information and planning frameworks with the provinces and other strategic allies.

On February 20, 1995, federal and provincial ministers of energy and environment approved a National Action Program on Climate Change (NAPCC). The NAPCC was prepared for tabling at the first meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change on April 5, 1995, in Berlin. It sets out the strategic directions Canada will follow in pursuit of its objective to

stabilize greenhouse gas emissions at 1990 levels by 2000, and provides guidance for further actions beyond the year 2000. The action program highlights continuing and enhanced activities, new measures and proposed measures.

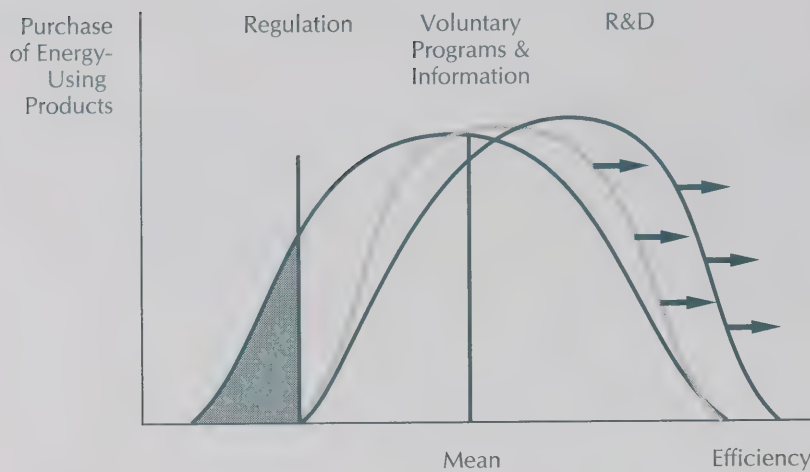
The approach set out in the NAPCC includes continued support for voluntary action to limit greenhouse gas emissions. Such action across a broad range of sectors is critical to the success of the action program. To provide greater impetus, federal and provincial ministers of energy and environment agreed to launch a Voluntary Challenge and Registry Program as part of the NAPCC. This federal-provincial initiative will broaden awareness of the need to act and will publicize the plans and accomplishments of organizations that succeed in reducing greenhouse gas emissions. The Minister of Natural Resources is the champion of the Voluntary Challenge.

Energy-Efficiency Strategy

Many of NRCan's EAE initiatives deal solely with energy efficiency. These are presented in chapters four through seven, according to end-use sector — buildings, equipment, industry and transportation. The goal is to improve energy efficiency by:

- upgrading the energy efficiency of new and existing buildings, equipment, systems and vehicles;
- ensuring that energy-consuming appliances and equipment are used in the most energy-efficient way (e.g., keeping furnaces well-tuned and operating vehicles at optimal speeds);
- influencing the choices of individuals and organizations (e.g., to purchase more energy-efficient equipment);
- influencing the daily energy-use practices of individuals and organizations (e.g., to use public transit instead of personal vehicles); and

Figure 1.3
Moving the Market



Source: NRCan.

- developing advances in available technology to provide consumers with continuously expanding opportunities for energy efficiency.

NRCan's key policy tools are:

- regulation — setting energy performance levels and labelling requirements for certain types of equipment, and working with provincial governments to improve the energy-efficiency aspects of Canadian building codes;
- information — providing information to specific groups of energy consumers;
- voluntary programs — working with companies and institutions to establish and achieve energy-efficiency objectives; and
- R&D — supporting development and deployment of more energy-efficient equipment, processes and technologies.

Figure 1.3 shows how these policy tools work together to reduce the amount of energy needed to obtain a certain level of service. Regulation eliminates the less energy-efficient items from the marketplace. Information and voluntary programs convince consumers to purchase the most

energy-efficient items available and to use them correctly. R&D creates more energy-efficient technologies for the marketplace.

Alternative Energy Strategy

In the short term, improving energy efficiency can contribute significantly to energy savings and environmental objectives. In the longer term, however, holding atmospheric emissions in check will probably require fundamental changes in the way we produce and use energy. That may mean relying considerably more on alternative energy sources, among other changes.

Alternative energy includes renewable sources other than large hydroelectric facilities (e.g., bioenergy and solar energy) and new applications of conventional sources (e.g., natural gas used as an automotive fuel). Some technologies, especially for propane as a vehicle fuel and forestry biomass, are already commercially available and accepted. Some have found applications in specialized markets, such as remote communities. Other technologies are still in the early stages of development. Chapters eight and nine describe what NRCan is

Information and
voluntary programs
convince consumers to
purchase the most
energy-efficient items
available and to use
them correctly.

doing to help develop and encourage the use of alternative sources of energy.

NRCan's activities in the area of alternative transportation fuels are directed toward the most technically promising and most marketable fuels. These include propane, natural gas, methanol and ethanol. Federal initiatives are helping to expand the infrastructure (e.g., availability at fuel stations) for these fuels and their markets, especially in urban regions with air-quality problems that can be alleviated through greater use of alternative transportation fuels. R&D continues to examine ways to improve the options for these fuels. For the longer term, NRCan is assisting the development of hydrogen and fuel-cell technologies and electric vehicles.

Renewable sources of energy, such as hydraulic, biomass, wind and solar, are generally recognized as important potential contributors to the reduction of global warming. NRCan's support for renewable energy is allocated largely to R&D to reduce costs, improve performance, develop safety and performance standards, and increase the scope for renewable energy technologies. Other activities involve providing buyers with reliable information and assessing economic and environmental factors.

■ ■ ■ ■ ■
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Chapter Two

The *Energy Efficiency Act* and Regulations

The Act

The *Energy Efficiency Act* received Royal Assent on June 23, 1992, and came into full force on January 1, 1993. The act gives the federal government the authority to make and enforce regulations concerning EAE, primarily:

- energy performance levels for energy-using products, doors and windows that are imported or shipped between provinces;
- the energy labelling of energy-using products, doors and windows that are imported or shipped between provinces; and
- the collection of statistics and information on energy use and alternative energy.

Under the act, before a prescribed product is imported into Canada or shipped between provinces, the dealer must submit an energy-efficiency report that describes the product and its energy-efficiency performance. In addition, a dealer who imports a prescribed product must provide NRCan with customs-clearance documents regarding the product shipment and the purpose of importation. The Minister has the authority to designate inspectors to ensure compliance with the provisions of the act and regulations. In addition, the Governor in Council may make regulations regarding:

- the testing of energy-using products;
- the detention, disposition or destruction of things seized;
- exemptions; and
- carrying out the provisions of the act.

The Regulations

Energy Performance Levels

The *Energy Efficiency Regulations*, which took effect on February 3, 1995, established energy performance levels for the following products:

- a) major residential appliances — electric clothes dryers; clothes washers; integrated over/under washer-dryers; dishwashers; refrigerators, freezers and combination refrigerator-freezers; and electric and gas ranges;
- b) space-conditioning equipment — room air conditioners; single-package and split-system air conditioners and heat pumps; ground- or water-source and internal water-loop heat pumps; and gas furnaces;
- c) water-heating equipment (oil-, gas- and electric-fired); and
- d) other energy-using equipment — fluorescent lamp ballasts and electric motors.

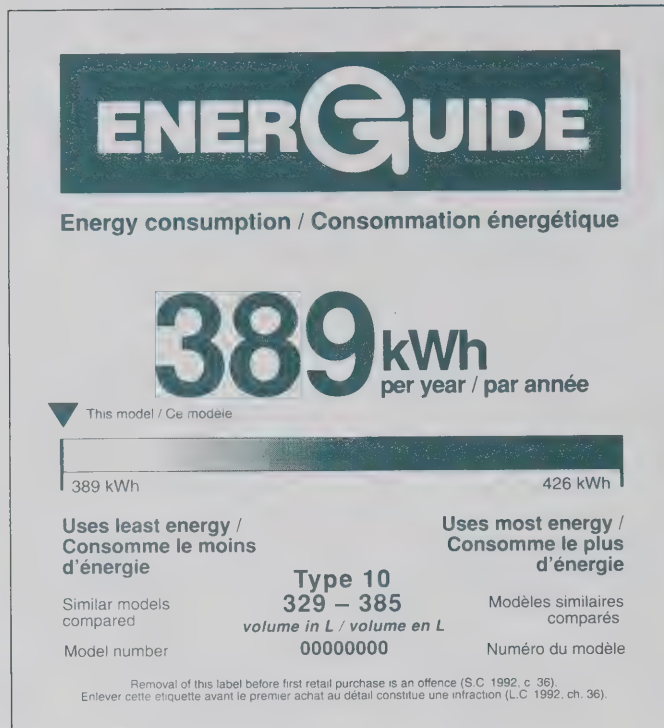
These energy-using products account for about 60 per cent of residential energy demand.

The regulations will phase out less-efficient equipment from the Canadian market. They complement energy-efficiency regulations currently in effect in Ontario, British Columbia, Quebec and Nova Scotia, and parallel regulations in the United States. The minimum performance levels for products covered by the federal regulations are largely harmonized with the levels prescribed for the same products by provincial regulations applicable to products sold within their borders.

The *Regulatory Impact Analysis Statement* (RIAS), published with the regulations in the November 1994 *Canada Gazette*, gave

The regulations
will phase out
less-efficient
equipment from
the Canadian
market.

Figure 2.1
EnerGuide Appliance Label



The EnerGuide label gives purchasers comparative information about the energy consumption of each model of a product, enabling them to consider energy-cost savings when buying this product.

NRCan's estimates of the annual energy savings and annual reduction in carbon dioxide (CO₂) emissions that will result from the regulations. The RIAS indicated that more than 43 PJ of energy would be saved in the year 2000 (about 3 per cent of residential energy demand in that year), increasing to 134 PJ in 2020. The regulations would decrease CO₂ emissions in the year 2000 by 4 to 6.4 megatonnes (depending on assumptions regarding the type of energy used to generate electricity), and by 12 to 19 megatonnes in 2020.

EnerGuide Labels

The regulations also provide a new regulatory basis for the EnerGuide Program, which began in 1978. The EnerGuide label, which must be affixed to prescribed products, gives purchasers comparative information about the energy consumption of each model of a product, enabling them to consider energy-cost savings when buying this product. The products that must be labelled under the EnerGuide Program are:

- a) electric clothes dryers;
- b) clothes washers;
- c) dishwashers;
- d) electric ranges;
- e) freezers;
- f) integrated over/under washer-dryers;
- g) refrigerators and combination refrigerator-freezers; and
- h) room air conditioners.

EnerGuide labels for major household appliances describe energy performance in annual kilowatt hours (see Figure 2.1). EnerGuide labels for room air conditioners describe energy performance as an energy efficiency ratio (see Figure 2.2). These labels give consumers consistent and verifiable energy-efficiency information they can use when selecting an appliance.

The new EnerGuide label has two significant features. First, it provides average annual

energy-consumption figures, which are based on standardized energy-efficiency testing procedures. The annual consumption figure simplifies the calculation of the lifetime operating cost of the product model, usually considered the 'second price tag'. Second, for consumers wishing a visual comparison, the energy-efficiency range appears on the label. This is a bar with a pointer indicating how the model's energy consumption compares with that of other models of the same product. Thus, the new label helps consumers make informed purchasing decisions in terms of the energy efficiency of the product.

Energy-Efficiency Report

Section 5 of the *Energy Efficiency Act* requires dealers to submit an energy-efficiency report to the Minister of Natural Resources. In accordance with Schedule IV of the *Energy Efficiency Regulations*, the report includes information concerning the product's energy-efficiency performance.

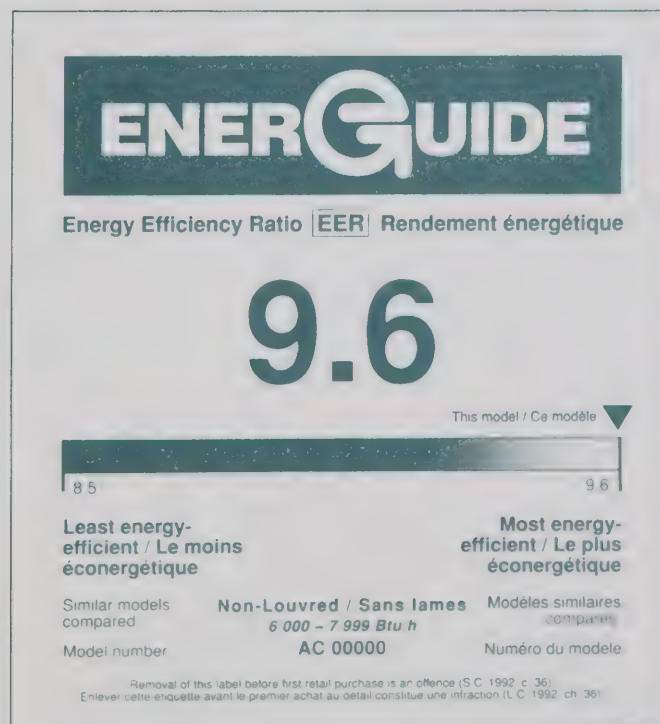
Verification Mark

To ensure that products meet the energy performance levels set out in the regulations, the energy performance of the product must be verified by a certification organization or a province, if the provincial energy performance levels are equivalent to or exceed federal levels. The certification agency must be accredited by the Standards Council of Canada. The verification mark must be placed on the exterior of the product before it is sold or leased.

Customs Reports

The *Energy Efficiency Regulations* also require dealers who import a prescribed product to include on the Revenue Canada customs release document specific information regarding the product — the product's name, brand and model number, the dealer's name and address, and the purpose for which the product is being imported. Customs sends these reports to NRCan.

Figure 2.2
EnerGuide Room Air Conditioner Label



Consultation and Communications

In developing the regulations, NRCan consulted more than 1000 stakeholders, including:

- provincial and territorial governments, other federal government departments and the U.S. government;
- energy utilities;
- manufacturers of prescribed products;
- trade and manufacturing associations; and
- public interest organizations, including environmental and consumer groups.

Initially, NRCan distributed more than 1000 copies of two discussion papers, *Regulation of Energy Efficiency and Labelling of Equipment in Canada* and *The Equipment Regulation and Labelling Program — How We'd Like It to Work*. In August 1993, these stakeholders received a copy of the draft regulations that had been submitted to the Department of Justice. When NRCan distributed the *Canada Gazette* Part I version of the regulations to these same stakeholders in March 1994, the department outlined how the regulations had changed since the August 1993 version and asked for final comments. Based on stakeholders' feedback, the regulations were revised and approved by the Governor in Council in November 1994. They came into force on February 3, 1995.

Since the regulations came into force, NRCan has produced and distributed various documents to educate interested parties on the regulations' requirements and benefits, including the following fact sheets:

- reports under section 5 of the *Energy Efficiency Act*;
- how to import an energy-using product into Canada;
- energy-efficiency verification marks;
- exemptions from the *Energy Efficiency Regulations*; and

- EnerGuide labels for energy-using products.

NRCan also distributed a document on the department's compliance policy that gives general information on the act and the regulations. Finally, NRCan periodically publishes *The EnerGuide Reporter*, a newsletter about the regulations, development of standards, regulatory requirements, marketing initiatives and related activities.

Compliance

Voluntary Compliance

NRCan's approach to compliance is outlined in "Compliance Policy for the *Energy Efficiency Act* and the *Energy Efficiency Regulations*," which was released in March 1995. NRCan is committed to achieving a high level of compliance with the act and the regulations. The department believes that a high level of voluntary compliance is most likely when all parties affected by the act and the regulations support them. This philosophy is reflected in the operating principles that will be used to administer the act, as follows:

- consulting stakeholders;
- minimizing the regulatory burden;
- harmonizing with other jurisdictions;
- cooperating with key players; and
- informing regulatees and the public.

Monitoring Imports

To ensure that imported products comply with the regulations, monitoring at border points has been instituted in collaboration with customs. The energy efficiency of products reported on customs documents is verified against information in NRCan's database. Officials follow up on cases of non-compliance or submission of incomplete customs reports.

Third-Party Monitoring

Third-party monitoring is carried out by independent certification organizations such as the Canadian Standards Association,

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In developing the
regulations, NRCan
consulted more than
1000 stakeholders.

Canadian Gas Association, Underwriters' Laboratory, Warnock Hersey and ETL Testing Laboratories Inc.

Inspections

NRCan is consulting provincial authorities on the most efficient way to monitor compliance through inspection. Since extensive fieldwork is expensive and disrupts business activities, this compliance measure is regarded as a last resort to be used only in cases of serious and systematic contravention of the regulations.

Further Regulatory Development

Now that the *Energy Efficiency Regulations* are in effect, NRCan is developing or considering amendments that address six issues:

- adding fluorescent lamps and incandescent reflector lamps for which the U.S. *Energy Policy Act* of 1992 established performance levels;
- adding products covered under provincial regulations established since the first federal regulations were designed;

- increasing the performance standards for products included in the first federal regulations;
- adding products being considered for regulation by the U.S. Department of Energy;
- adding commercial and industrial products not currently regulated in other jurisdictions. These were identified and ranked in an NRCan-commissioned study by the Centre de recherche industrielle du Québec, which was the subject of a workshop with stakeholders in November 1994; and
- adding products regulated in the United States but not by any province in Canada.

All stakeholders will have an opportunity to comment on proposed amendments to the regulations before they are prepublished in Part I of the *Canada Gazette*.



Efficiency and Alternative Energy Programs

Overview

Chapter one sets out the energy context and policy framework for NRCan's EAE program. Chapter two outlines the regulation-making powers under the *Energy Efficiency Act*, the first energy performance and labelling regulations, the consultation process, compliance provisions, and current work to expand the coverage of the regulations. The remaining chapters describe each of NRCan's 36 EAE program initiatives. Chapter three outlines three initiatives of a general nature. Chapters four to seven detail 23 energy-efficiency initiatives in the four sectors that use energy: buildings, equipment, industry and transportation. Chapters eight and nine set out program initiatives to increase the use of alternative energy: five initiatives on alternative transportation fuels in chapter eight, and five on renewable energy in chapter nine.

For each of the 36 EAE program initiatives, this report sets out their:

- purpose — what they are trying to achieve;
- activities — what they do to achieve their purpose; and
- achievements from April 1, 1994 to March 31, 1995.

Table 3.1 lists each of these initiatives and expenditures on them in 1994–95.

Many of the EAE program initiatives described in this report are the result of science and technology development supported by the government's interdepartmental Program of Energy Research and Development (PERD). PERD is the only federal R&D program that focuses specifically on the energy sector, to improve its contribution to the Canadian economy and its consequences for the environment.

In undertaking its EAE program activities, NRCan cooperates closely with provincial and territorial departments of energy. This work takes place on several levels:

- NRCan managers and staff working with their provincial and territorial counterparts on a specific program initiative;
- NRCan developing bilateral relationships with interested provinces or territories to deliver EAE program initiatives — as of March 31, 1995, NRCan had signed letters of cooperation on EAE program delivery with the Saskatchewan Department of Energy and Mines, the Nova Scotia Department of Natural Resources, the Newfoundland Department of Natural Resources, and the British Columbia Ministry of Energy, Mines and Petroleum Resources;
- NRCan participating as a member of the intergovernmental Conservation and Renewable Energy Subcommittee (CARES) under the Advisory Committee on Energy; and
- NRCan receiving R&D advice from provinces and other stakeholders participating in technical or business advisory committees such as the Minister's National Advisory Council to CANMET.

Other federal departments also have initiatives to support EAE. For example, other federal departments conduct EAE research under PERD. Tax relief provisions, such as the absence of a fuel excise tax on natural gas, propane, neat methanol, ethanol and the alcohol portion in ethanol- and methanol-gasoline blends, are another measure. And Class 43 of the *Income Tax Act* provides an accelerated capital-cost allowance for several energy-efficient and renewable-energy technologies in certain circumstances.

Table 3.1
EAE Initiatives and Expenditures for 1994-95 (\$ million)

General Programs	5.5
Consumer Information	
Advanced Integrated Energy Systems Technologies	
National Energy Use Database	
Energy Efficiency — Buildings	14.2
Federal Buildings Initiative	
National Energy Codes for Buildings and Houses	
R-2000 Home Program	
Home Energy Retrofit	
Energy Innovators	
Building Information Transfer	
Federal Industrial Boiler Program	
Buildings Energy Technology Advancement Plan	
• Residential	
• Large	
• Passive Solar	
Heat Management R&D	
Energy Efficiency — Equipment	3.6
Equipment Energy Performance Regulations	
EnerGuide	
Energy Efficiency — Industry	14.9
Industrial Energy Efficiency	
Canadian Energy Management and Environmental Training	
Industry Energy R&D	
Industrial Targeted Technologies	
Advanced Technologies for Process Optimization and Control	
Minerals and Metals Technologies	
Gas Technologies	
Energy Efficiency — Transportation	3.4
Motor Vehicle Fuel Consumption	
Transportation Energy Efficiency	
Transportation Efficiency R&D	
Alternative Energy — Alternative Transportation Fuels	6.2
Propane	
Natural Gas	
Methanol	
Ethanol	
Alternative Transportation Fuels R&D	
Alternative Energy — Renewable Energy Sources	10.1
Renewable Energy Market Assessments	
Information and Awareness	
Energy from the Forest (ENFOR)	
Canada-Prince Edward Island Cooperation Agreement on	
Alternative Energy Development and Energy Efficiency	
Renewable Energy Technologies	
TOTAL	57.9

Note: This table presents estimated NRCan expenditures during fiscal year 1994-95 on EAE initiatives by end-use sector or by type of alternative energy; several initiatives that cover several or all sectors are listed under "general programs." It does not include expenditures on R & D initiatives related to fossil fuel production.



Chapter Three

General Programs

Consumer Information

Purpose

To increase Canadians' awareness of the environmental impact of energy use and to encourage Canadians to adopt energy-efficient practices and choose alternative forms of energy.

Activities

NRCan promotes greater energy efficiency and the use of alternative energy through a broad range of marketing activities.

The department produces and markets numerous publications, some for the general public and some for specialized readership. These publications offer information on a wide range of topics, including alternative transportation fuels; energy efficiency in the home; and energy-efficient office equipment, heating systems, appliances, lighting products and vehicles. This activity includes documentation, promotional products and marketing support for all EAE program initiatives.

NRCan's extensive exhibits program focuses on initiatives such as the R-2000 Home Program, EnerGuide, the national energy codes, the Federal Buildings Initiative, Energy Innovators and Transportation Energy Efficiency.

Achievements in 1994-95

- NRCan distributed about 1.5 million copies of more than 300 EAE publications to individuals and program allies.
- The department produced two animated public-service announcements featuring the EnerCat character. These messages are broadcast by television stations across the country to remind Canadians to use energy efficiently.

- NRCan produced and distributed 72 000 copies of the 1995 edition of the Energy and the Environment Calendar, which features environmental tips and children's drawings to promote energy efficiency.

Advanced Integrated Energy Systems Technologies

Purpose

To develop technology, technology transfer, financing and marketing options for integrated community energy systems.

Activities

This program, managed by CANMET's Energy Research Laboratories (ERL), helps Canadian communities become more energy efficient by applying technologies that interconnect heat sources and sinks, and by finding ways to satisfy the demand for cooling with more efficient and ozone-friendly methods. Technologies include district heating and cooling, the combined production of heat and power, industrial waste-heat recovery and thermal storage.

The program works with Canadian industry, energy utilities, researchers, engineers and other levels of government to develop and transfer technology and to stimulate interest in community-based energy systems. It also evaluates opportunities to develop and install community energy systems and provides financial and technical support for implementation.

Integrated energy systems are supported in many ways. For example, CANMET organizes seminars to inform energy utilities and municipalities about developments in other countries. It also advises government departments at both federal and provincial levels on ways to incorporate energy systems into their planning.

NRCan's extensive exhibits program focuses on initiatives such as the R-2000 Home Program, EnerGuide, the national energy codes, the Federal Buildings Initiative, Energy Innovators and Transportation Energy Efficiency.

Achievements in 1994-95

- In Cornwall, Ontario, CANMET sponsored a meeting, including a trade show and tour, on community energy systems. This event attracted 200 participants from across North America and Europe. CANMET staff subsequently received requests to meet with energy utility and consultant groups to explore district energy opportunities.
- CANMET collaborated with Nova Scotia Power Inc. to complete a detailed feasibility study of converting the Tuft's Cove Power Plant and Department of National Defence facilities in Dartmouth to use hot water from Nova Scotia Power. This alternative would reduce operating costs, and decrease CO₂ emissions by more than 60 per cent.
- CANMET helped to fund the expansion of the Oujé-Bougoumou biomass-based district heating system in northern Quebec. This community-operated system uses waste wood from local sawmills.
- CANMET provided financial and technical support for the Grassy Narrows First Nation biomass-based district heating system. The heating plant was completed in 1994 and the distribution system will be finished in 1995.
- Working with Stelco, CANMET completed a preliminary evaluation that confirmed the potential for displacing commercial and residential fossil fuel heating in downtown Hamilton with discarded heat from the Stelco plant.
- In partnership with Ontario Hydro and the Municipality of Metropolitan Toronto, CANMET completed a major feasibility study and evaluation of the potential of district heating and cooling to reduce emissions of CO₂ and ozone-depleting substances in Toronto. The report indicates that district heating projects of more than 7000 MW could be viable and could exceed the city's CO₂ reduction target for 2005 by about 20 per cent.

- ERL completed the first phase of the "Energy Showcase" development and demonstration project, including an ice-slurry cooling system with ice storage for load management. With support from CANMET and the National Research Council, the manufacturer of the technology, Sunwell Engineering of Woodbridge, Ontario, is now a major supplier of ice-slurry systems to Japan.
- CANMET continued work with cold-water friction-reducing additives, patented by CANMET and St. Mary's University in 1993, and confirmed pumping-energy savings of up to 80 per cent.

National Energy Use Database

Purpose

To improve our understanding of secondary energy consumption in Canada to enable decision makers to assess progress in improving energy efficiency and analyze opportunities for further improvement.

Activities

The National Energy Use Database (NEUD) establishes processes for the regular collection and analysis of national data on energy consumption at the end-use level, the characteristics of buildings and energy-using equipment, the attitude and behaviour of Canadian consumers toward energy use, and the adoption of energy-efficient technologies. NEUD reviews data sources in each end-use sector, assesses data needs, and expands or creates data surveys as required.

NEUD facilitates the establishment of data and analysis centres in Canadian universities on specific energy-consuming sectors; thus, the national database is easily available to research personnel. These centres compile, organize and analyze energy end-use data and advise NRCan on the creation of new data sources. In 1995, NRCan funded four centres and created one new one.

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*Working with Stelco,
CANMET completed
a preliminary
evaluation for
displacing
commercial and
residential fossil fuel
heating in downtown
Hamilton with
discarded heat from
the Stelco plant.*

The four established centres are:

- the Automobile Mobility Data Compendium at Université Laval in Ste-Foy, Quebec, which examines the use of private vehicles to improve understanding of their impact on personal mobility, energy consumption and environmental quality in association with the Groupe de recherche interdisciplinaire mobilité, environnement et sécurité;
- the Canadian Industrial Energy End-Use Data and Analysis Centre at Simon Fraser University in Vancouver, which examines patterns of energy use by industry in association with the university's School of Resource and Environmental Management;
- the Canadian Commercial Energy End-Use Data and Analysis Centre at McMaster University in Hamilton, Ontario, which examines energy use in the commercial sector in association with McMaster's Institute for Energy Studies; and
- the Canadian Agricultural Energy End-Use Data and Analysis Centre at the University of Saskatchewan, Department of Agricultural Economics in Saskatoon, which examines energy use in the agricultural sector.

Achievements in 1994-95

- NRCan published a statistical report entitled *1993 Survey of Household Energy Use: National Results*. The report discusses the characteristics of Canadian household equipment and housing stock collected for NRCan in a March 1993 Statistics Canada survey.
- The department sponsored an expansion of Statistics Canada's 1994 *Repair and Renovation Survey* to collect data on energy-retrofit activity in Canadian homes. Field work was completed in March 1995.
- The department sponsored an expansion of Market Facts of Canada Limited's 1994 *Household Equipment Survey* to collect detailed information on household equipment acquired by Canadians in 1994. The survey was conducted in January 1995.
- NRCan completed a feasibility study and initiated design of a survey to collect information about homes built in 1994. Field work is scheduled for May 1995.
- The department sponsored the National Private Vehicle Use Survey to collect monthly data on private-vehicle fuel consumption, kilometres driven, and vehicle and household characteristics. Field work began in October 1994 and has been repeated monthly since then.
- NRCan sponsored an expansion of Statistics Canada's Industrial Consumers of Energy Survey for reporting year 1994 from about 230 respondents to more than 1000 respondents to improve coverage of large energy-using sectors. The survey collects data on energy use by fuel for the Canadian Industrial Program for Energy Conservation to monitor progress in energy efficiency.
- The department created the first Canadian database on EAE programs. Using this database, NRCan produced the 1994 edition of the *Directory of Efficiency and Alternative Energy Programs in Canada*, which presents summary data on the EAE programs of the federal and provincial governments.
- NRCan established a fifth data and analysis centre, the Canadian Residential Energy End-use Data and Analysis Centre, at the Technical University of Nova Scotia in Halifax. The centre's mandate is to organize data on energy-using equipment and buildings, identify major information gaps, propose a data-collection strategy to supplement information sources, and establish expertise in the analysis of energy use in the Canadian residential sector.



Chapter Four

Energy Efficiency — Buildings

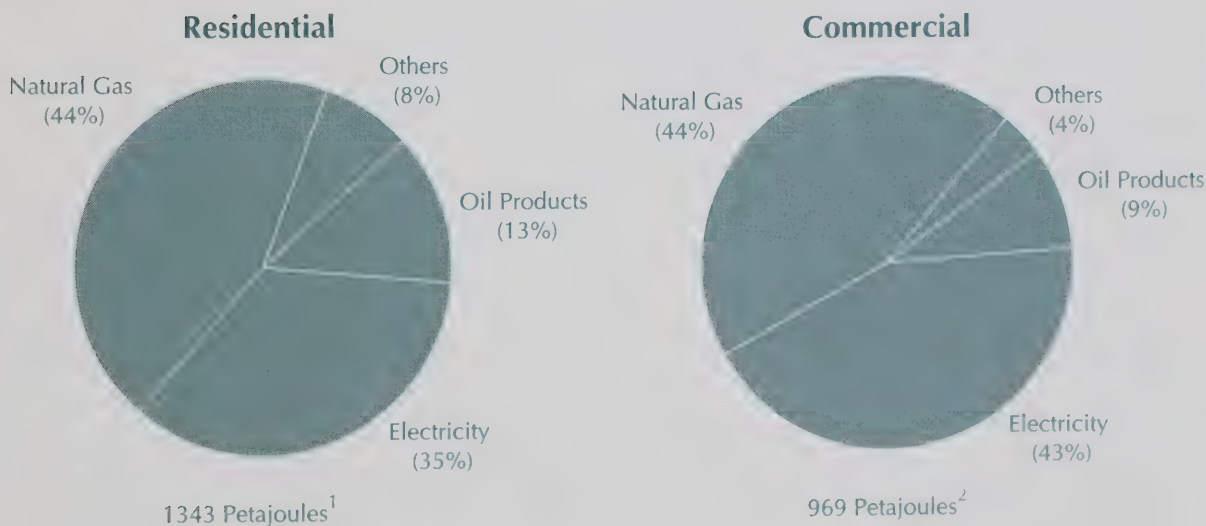
Energy Use

A building is a system comprising a building envelope, architectural features, mechanical equipment and occupants. The building envelope is made up of all the materials and surfaces in the building shell, including walls, ceilings, roof, basement walls, windows and doors. The architectural features determine the degree to which the building gets energy from the sun. Mechanical equipment is the energy-using component of the system, and it includes all the equipment and appliances related to space heating and cooling, ventilation, lighting, water heating, cooking and humidifying. The interaction of the building envelope, the architectural

features, the mechanical equipment and the energy practices of the occupants determines the overall energy use of the building. This chapter focuses on these aspects of energy efficiency.

In 1993, energy use in residential and commercial buildings amounted to some 2312 PJ, equal to 33 per cent of total secondary energy use. Residential buildings accounted for approximately 1343 PJ (19 per cent of secondary energy use), while commercial buildings accounted for approximately 969 PJ (14 per cent of secondary energy use).

Figure 4.1
Residential and Commercial Energy Use by Fuel, 1993



1. Excludes farm motive use.

2. Excludes aviation fuels, motor gasoline and diesel fuel oil from non-public administration.

Sources: NRCan, Residential End Use Model.

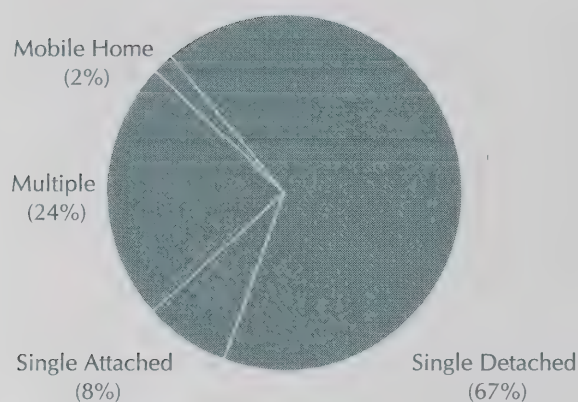
NRCan, Commercial End Use Model.

Statistics Canada, "Quarterly Report on Energy Supply-Demand in Canada,"

Cat. no. 57-003, 1993-IV.

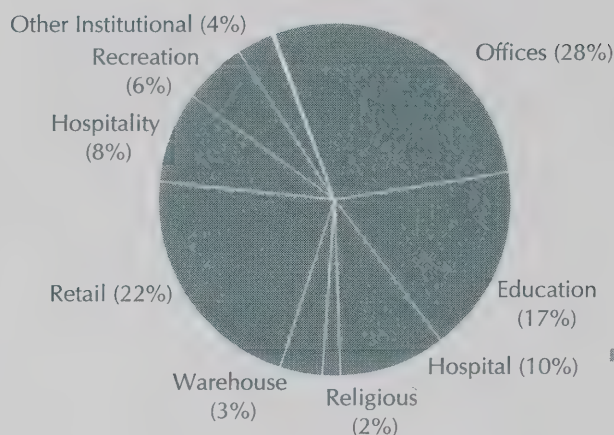
Figure 4.2
Residential and Commercial Energy Use by Building Type, 1993

Residential



1343 Petajoules¹

Commercial



969 Petajoules²

1. Excludes farm motive use.

2. Excludes aviation fuels, motor gasoline and diesel fuel oil from non-public administration.

Sources: NRCan, Residential End Use Model.

NRCan, Commercial End Use Model.

Statistics Canada, "Quarterly Report on Energy Supply-Demand in Canada,"

Cat. no. 57-003, 1993-IV.

Although residential and commercial buildings differ substantially in the way they consume energy, they are similar in the fuel mix they use (see Figure 4.1). Natural gas is the dominant fuel, accounting for 44 per cent of energy use in each of these sectors.

In the residential sector, electricity accounts for the second-largest share (35 per cent) and oil accounts for the third-largest share (13 per cent) of energy use.

In the commercial sector, the use of electricity has increased throughout the decade; its share of energy use, about 43 per cent, is now almost equivalent to that of natural gas. Oil accounts for approximately 9 per cent of commercial energy use. In both cases, the "other" fuel use is almost entirely biomass (wood) and liquid petroleum gases.

Canadian residential and commercial building energy use is compared for different building types in Figure 4.2. In the residential sector, single detached houses are the major energy-using group. In the commercial sector, energy use occurs in diverse market segments and building types, with retail, education and office buildings accounting for two thirds of energy use.

Developments in Energy Efficiency

From 1990 to 1993, residential energy use increased by 5 per cent. However, residential sector energy intensity, defined as energy use per household, decreased by 2 per cent from 1990 to 1993. Improvements in energy efficiency, including building energy efficiency, result in lower energy intensity.

Since the late 1970s, many governments have begun to include energy-efficiency standards in building codes, which affect the energy requirements of new houses. Some jurisdictions, such as Ontario, have done so aggressively. Since 1990, Ontario has increased the energy-efficiency requirements of the provincial building code twice.

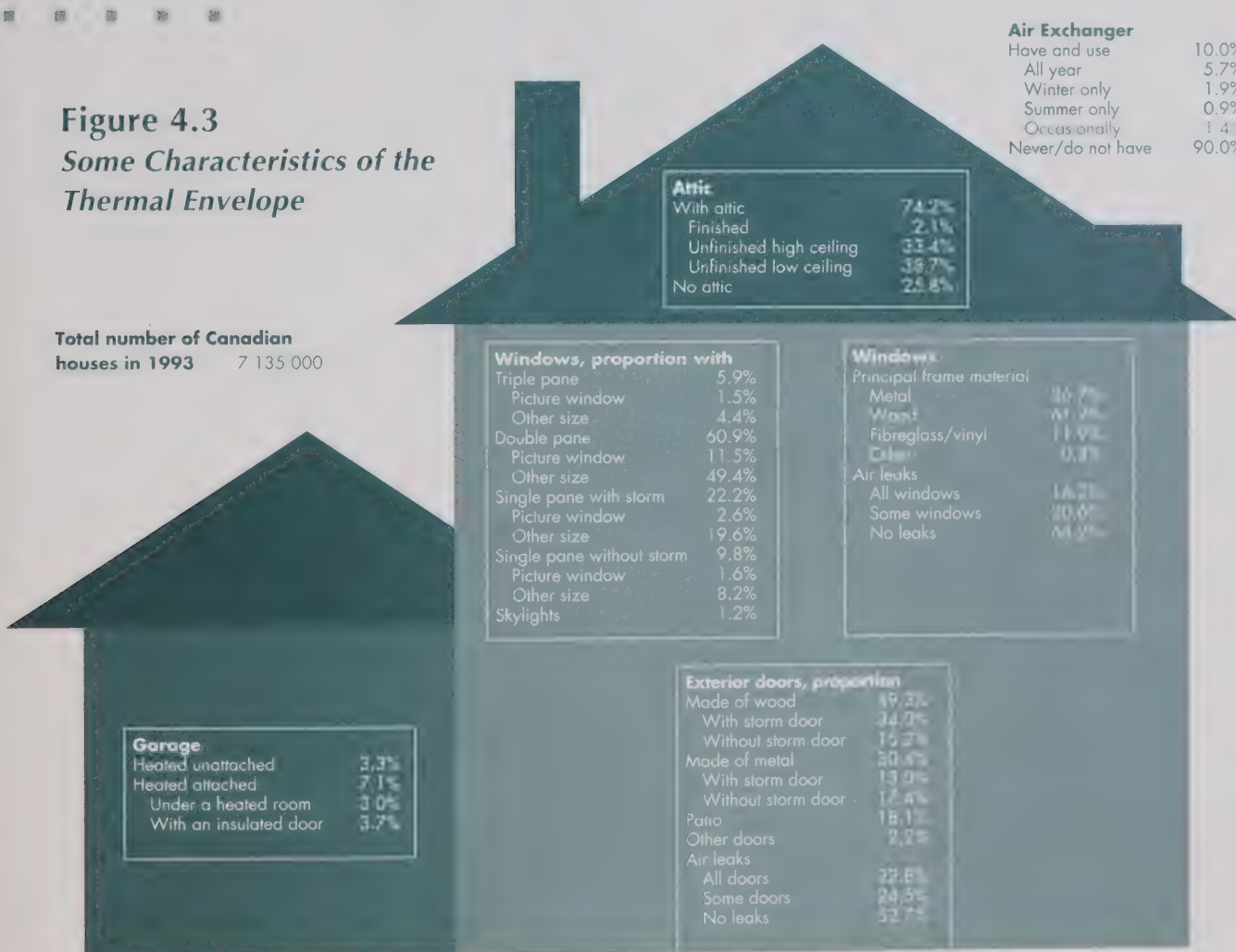
Other developments concerning the energy efficiency of new houses include recent revisions to the R-2000 technical standard that improve the energy efficiency of new R-2000 homes by some 15 per cent. Furthermore, 10 Advanced Houses — super-energy-efficient houses designed to

test emerging energy-efficient housing technologies — have been built in various cities. These represent the energy-efficient houses of the future.

Canada's understanding of energy use in the home took a giant step forward when the results of the first national Survey of Household Energy Use (SHEU) were released. Statistics Canada conducted the SHEU in 1993 for NRCan under the auspices of the National Energy Use Database, with support from the provinces of Nova Scotia, New Brunswick, Ontario, Manitoba and Saskatchewan.

Figure 4.3
Some Characteristics of the Thermal Envelope

Total number of Canadian houses in 1993 7 135 000



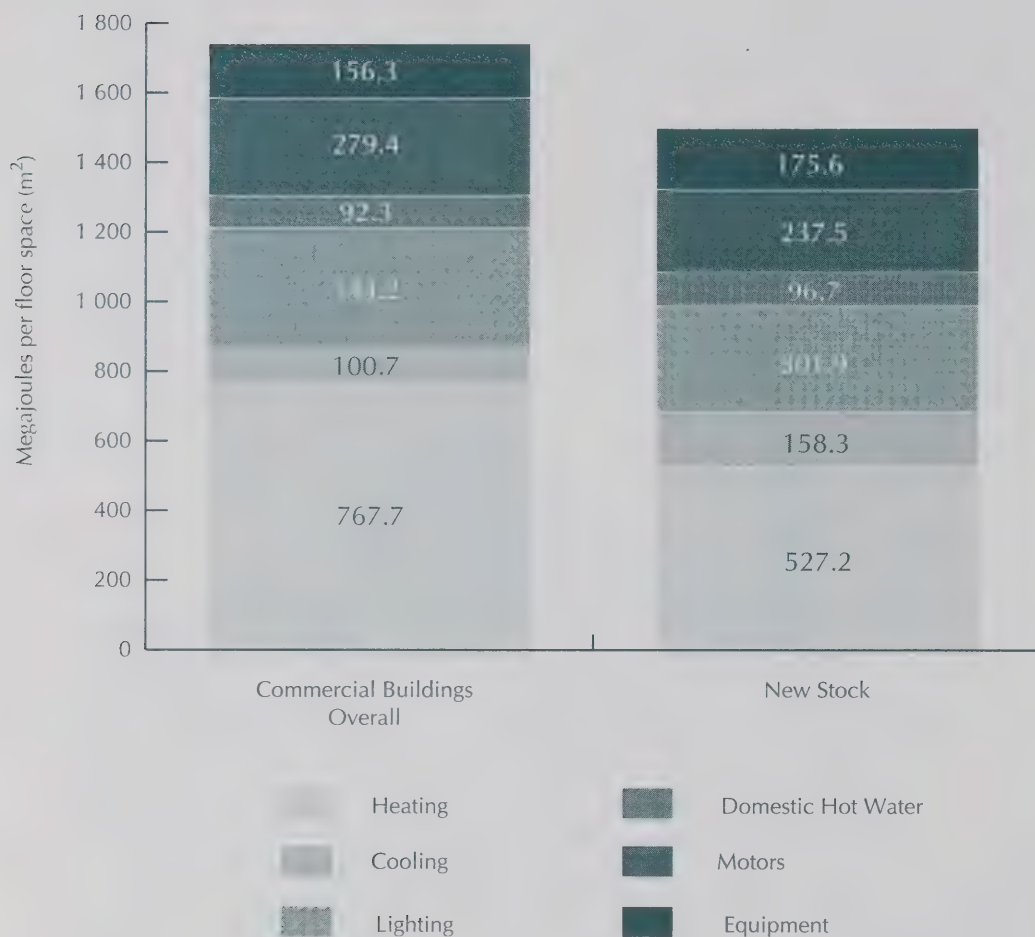
Threshold below which estimated percentages can contain an error equal to the estimate itself: 1%

Source: NRCan, "1993 Survey of Household Energy Use — National Results," 1994.

Basement	
With basement	90.0%
Full basement	70.8%
Partial basement	11.7%
Crawlspace	7.5%
No basement	10.1%

Average area of basement	98 m²
Heated portion of basement	
Entire basement	66.2%
More than half	5.5%
Half	4.4%
Less than half	1.4%
Not heated	22.5%

Figure 4.4
Commercial Sector Output Energy Intensity for
Buildings Overall and for New Stock, 1993



Source: NRCan, Commercial End Use Model.

Although many Canadian homeowners have improved the thermal envelope of their dwellings, there is still significant potential for energy-efficiency upgrades.

The SHEU provides some interesting insights into the Canadian housing stock and its characteristics. For example, nearly two thirds of homeowners with basements or crawlspaces have increased the basement-wall insulation; 52 per cent have upgraded the airtightness around doors; 41 per cent have done the same for windows; and 38 per cent have upgraded roof and attic insulation. However, although many Canadian homeowners have improved the thermal envelope of their dwellings, there

is still significant potential for energy-efficiency upgrades — 69 per cent of Canadian households were built before 1978, when the energy-efficiency requirements of building codes were much less stringent. Figure 4.3 presents a snap-shot of the characteristics of the thermal envelope for all houses in Canada.

In the commercial sector, the average energy intensity (energy use per square metre of floor space) for commercial buildings

decreased by 11 per cent between 1990 and 1993, despite an 8 per cent increase in total commercial energy use.

The recent decline in commercial-sector energy intensity is partly due to the greater energy efficiency of new buildings. As illustrated in Figure 4.4, the energy efficiency of today's new buildings is almost 14 per cent greater than that of the Canadian building stock as a whole. The efficiency of new buildings today is a result not only of improvements effected over the last 20 years, but also of recent revisions to the energy-efficiency component of provincial and municipal building codes. The most convincing example of these recent revisions is in British Columbia — the Vancouver building code now requires that new construction comply with energy-efficiency levels prescribed by the ASHRAE 90.1 standards, which are, on average, 50 per cent more energy efficient than requirements in other jurisdictions.

New attitudes to energy conservation also affect unit energy use. In a recent survey of Saskatchewan's commercial sector conducted by the Saskatchewan Energy Conservation and Development Authority, more than 75 per cent of the respondents said that they routinely turn off lights and lower thermostat settings overnight or when rooms are unoccupied. The survey also showed that 40 per cent of the respondents undertook energy-efficiency improvements in their buildings in the past five years.

Federal Buildings Initiative

Purpose

To help federal government departments and agencies implement energy-efficiency improvements in their facilities.

Activities

The Federal Buildings Initiative provides a full range of products and services for federal departments and agencies seeking to improve energy efficiency in their approximately 50 000 facilities. Through a key

strategy called savings financing, private sector energy-management companies secure private financing to retrofit federal buildings for energy efficiency, and recoup their investment from the resulting energy savings. Seminars and workshops are held in all regions of the country so that federal facility managers can learn about implementing energy-efficiency projects.

To facilitate implementation of the program in federal departments, the Federal Buildings Initiative has strategic alliances with energy utility companies, energy-management firms and manufacturers of energy-efficient products. A National Management Committee of representatives of federal departments and a series of regional implementation committees oversee program delivery.

Achievements in 1994–95

- All federal custodian departments now have energy-efficiency projects at the preliminary engineering, tendering or implementation phase.
- All federal custodian departments have agreed to develop long-term energy-management plans for their facilities and to report progress annually to NRCan. NRCan will include these progress reports in subsequent versions of this annual report to Parliament on the *Energy Efficiency Act*.
- The private sector invested about \$200 million in federal energy-efficiency projects involving 80 projects or some 2500 buildings. Projects to date in federal facilities will yield annual savings of approximately \$25 million.
- The Federal Buildings Initiative (FBI) received an award for "Entrepreneurial Excellence" in the public sector. The award was sponsored by five private sector firms and *Focus* magazine.
- To improve energy efficiency in their facilities, provincial and municipal governments are planning to use tools NRCan has developed as part of its FBI.

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The private sector
invested about
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federal energy-
efficiency projects
involving
80 projects
or some
2500 buildings.

National Energy Codes for Buildings and Houses

Purpose

To increase the energy efficiency of new Canadian buildings by setting minimum standards for thermal performance and promoting the incorporation of these energy codes into provincial and municipal building regulations.

Activities

After extensive consultation with the Provincial-Territorial Committee on Building Standards and provincial and territorial energy ministries, NRCan is contributing to the development of model codes for energy efficiency in new residential and commercial buildings to replace the 1983 Measures for Energy Conservation.

These model codes will provide thermal performance standards regarding the optimal level of energy efficiency based on regional construction costs, energy prices and climate. They will be available in both prescriptive and performance-based versions.

The codes were developed by a standing committee under the Canadian Commission on Building and Fire Codes, and were funded by NRCan, the Canadian Electrical Association, provincial and territorial energy ministries, and the National Research Council.

Achievements in 1994-95

- In partnership with provincial energy ministries, NRCan assessed the energy savings that would accrue from Manitoba's and British Columbia's adoption of the minimum standards set out in the new energy codes. NRCan also contributed to several other studies that would facilitate implementation of the energy codes.
- The department raised awareness of the codes among builders, designers and other stakeholders in the construction industry by distributing promotional materials for the national energy codes through travelling exhibits, presentations at conferences and trade shows, and articles in trade journals and newsletters.

- NRCan convened a workshop to consult industry and provincial stakeholders on the need and mandate for an implementation committee. Participants agreed that a national committee is needed to encourage development of core training materials and to coordinate other implementation issues for the provinces and industry. NRCan will be the secretariat of the Energy Code Coordinating Committee, which was formed to meet this need.

R-2000 Home Program

Purpose

To increase the energy efficiency of new houses.

Activities

The R-2000 Home Program sets a voluntary standard for energy efficiency in housing that exceeds current building codes. Research by NRCan and others ensures that the R-2000 standard evolves and maintains its position at the leading edge of housing technology.

The program trains house builders to meet the R-2000 standard, and it tests and certifies the houses. Through promotion, it encourages buyers to purchase houses that meet the R-2000 standard. NRCan manages the program nationally but it is delivered at the provincial level through partnerships typically comprising energy utility companies, the provincial government, the provincial home-builder association and financial institutions. Private sponsors of the program, such as product manufacturers and equipment suppliers, help to market R-2000 in return for the good will and publicity associated with the R-2000 name.

Achievements in 1994-95

- Just under 1000 R-2000 homes were built during the year. More than 8000 R-2000 homes have been built since the program started in the early 1980s.
- The first private sponsors joined the R-2000 Home Program, contributing significant marketing support. More than

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*Research by NRCan
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30 Canadian private and public sector organizations supported the program in 1994–95, contributing more than \$1.5 million to its operations.

- The program trained more than 1000 house builders. More than 8000 builders have been trained since the program began.
- NRCan introduced a new standard for the program, the first major technical change since it started in the early 1980s. The new standard, which came into force on April 1, 1994, increases energy efficiency by 15 per cent and, for the first time, includes several environmental and health features.

Corporation (CMHC) and other partners, to encourage homeowners to upgrade the energy efficiency of their homes while doing general renovations.

- The department began to develop national Home Energy Retrofit Guidelines with the National Research Council and the Canadian Electrical Association. These guidelines would facilitate the development of energy retrofit codes by jurisdictions interested in adding energy-efficiency measures to a building renovation code.
- With interested parties from across the country, NRCan initiated the development of guidelines for a home-energy rating system to satisfy the growing interest in rating the comparative energy efficiency of homes. National guidelines will offer consistency in evaluating houses and could provide a basis for financial institutions to develop preferential mortgage rates for energy-efficient houses.
- The department launched a Renovation Demonstration project with CMHC and the Canadian Home Builders' Association to show consumers how to renovate older houses to modern energy-efficiency and environmental standards. The first Renovation Demonstration house was completed in Red Deer, Alberta, in October 1994. Four "Open House" events held at the Renovation Demonstration house in October, which was Renovation Month, attracted more than 1500 visitors. Additional visitors attended at other times during the autumn of 1994.

The Energy

Innovators initiative

recruits Canadian

organizations to

register a corporate

commitment to energy

efficiency and become

Energy Innovators.

Home Energy Retrofit

Purpose

To encourage Canadians to make their homes more energy efficient, particularly when undertaking renovations.

Activities

The energy performance of most of the 7 million homes built before 1977 could be improved significantly. In fact, many homeowners could save up to 25 per cent of their heating costs through affordable upgrades. More than half of all homeowners say they plan renovations within the coming year. The Home Energy Retrofit initiative tries to ensure that energy retrofits are 'piggy-backed' onto home improvements. NRCan attempts to link the resources and activities of stakeholders and potential partners — such as provincial governments, energy utilities, trade associations, product and equipment manufacturers, and retailers — to ensure that they give energy-efficiency retrofits high priority.

Achievements in 1994–95

- NRCan launched *Retro Vision*, a newsletter that tells stakeholders about developments in home-energy retrofit. The department also launched a consumer information campaign, in collaboration with the Canada Mortgage and Housing

Energy Innovators

Purpose

To encourage corporations, institutions and municipalities to increase their energy efficiency.

Activities

The Energy Innovators (EI) initiative recruits Canadian organizations to register a corporate commitment to energy efficiency and become Energy Innovators. NRCan

encourages Energy Innovators to implement long-term energy-management plans and helps them start comprehensive building-retrofit programs.

The initiative provides Energy Innovators with information and ideas to help them identify and carry out projects, and gain access to training initiatives, ally networks, and other products and services. The EI initiative encourages the replication of projects from sector to sector and publicly recognizes Energy Innovators for their committed action.

Achievements in 1994-95

- The EI initiative recruited 75 (for a total of 200) Canadian corporations, institutions and municipalities to become Energy Innovators. The 200 participants control 50 million square metres of floor space, allowing widespread replication of retrofit projects.
- The EI initiative encouraged participants to undertake 38 pilot projects.

Building Information Transfer

Purpose

To provide information that encourages adoption of energy-efficient products and practices in the building sector.

Activities

NRCan assesses the availability of energy-efficiency information, and develops material to fill information gaps and updates material to reflect current technology. The department also supports industry association activities to promulgate information about energy-efficient practices.

Achievements in 1994-95

- NRCan assisted industry activities to deliver and promote a certification and energy-labelling program for windows and patio doors, endorsed by the general membership of the Canadian Window and Door Manufacturers' Association. NRCan proposed to R-2000 partners to include the association's window certification program in the R-2000 program.

- NRCan revised and distributed several consumers' guides to energy-efficient technology, including the *Consumer's Guide to Buying Energy-Efficient Windows and Doors*, and the *Home Heating and Cooling* series.

- The department participated in the Building Environmental Performance Assessment Criteria Foundation's activities to introduce a voluntary building-performance evaluation system in Ontario. Other partners in this venture include the Ontario government, Toronto Hydro and the Ontario Gas Association.

Federal Industrial Boiler Program

Purpose

To assist in the development and implementation of clean, energy-efficient combustion technologies for federally owned boilers.

Activities

The Canadian government owns 52 central heating plants, housing over 270 boilers that consume more than 8000 terajoules of fuel and produce over 650 tonnes of nitrogen oxide (NO_x) emissions and 400 000 tonnes of CO₂ annually. The Federal Industrial Boiler Program (FIBP) provides government departments with services to increase energy efficiency, reduce NO_x emissions and extend the useful life of boiler systems and auxiliary equipment. The program ensures that energy-efficient and environmentally responsible technologies are considered when departments replace or modify industrial heating plants. The application of proven technologies would reduce NO_x emissions by 50 per cent, increase energy efficiency by up to 5 per cent and reduce operating costs by 10 per cent.

Along with developing site-specific strategies to help industrial boiler operators meet higher equipment-performance targets, FIBP provides turnkey project management services on new or retrofit combustion technologies, including preparing technical

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The Federal

Industrial Boiler

Program provides

government

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services to increase

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reduce NO_x emissions

and extend the useful

life of boiler systems

and auxiliary

equipment.

specifications, reviewing tenders, and overseeing the installation and commissioning of new equipment. Other services include cogeneration feasibility studies, retrofit studies, non-destructive examinations of heating-plant equipment, life-cycle costing studies, on-site test burns, and technical workshops and seminars.

The program operates on a fee-for-service basis.

Achievements in 1994-95

- The Department of National Defence awarded FIBP a contract to manage heating-plant retrofits at several Canadian Forces bases. Overall energy savings from a retrofit currently under way at CFB Goose Bay are expected to yield a 3 per cent reduction in annual fuel consumption and reduce NO_x by 30 per cent.
- FIBP completed the second phase of its contract with Agriculture and Agri-Food Canada to manage the supply and installation of a \$1.5-million cogeneration system and new boiler-room equipment at the department's research centre in Vineland, Ontario. Phase II included the installation and start-up of the cogeneration system and new boiler-room equipment. Energy savings are expected to be \$150 000 annually.
- Correctional Service Canada awarded FIBP a contract to manage the removal of a boiler and to install two new high-pressure steam boilers with low NO_x burners and computerized burner-management and burner-control systems. The \$1.25-million project will reduce fuel consumption and environmental emissions in accordance with the Service's Environmental Pledges.
- FIBP completed several site-specific services for clients, including four non-destructive examination surveys, a retrofit survey, two cogeneration feasibility studies, a life-cycle costing study, a low-NO_x technology assessment study, and an end-use energy study.

Buildings Energy Technology Advancement (BETA) Plan — Residential Buildings

Purpose

To develop and commercialize energy-efficient technologies for residential buildings and encourage their adoption by the industry.


Activities

The application of advanced technologies could reduce energy consumption in the residential sector by 50 per cent. Strategic elements of the BETA Plan for residential buildings include technology development, technology transfer and quality assurance for the advancement of energy-efficient and environmentally responsible housing technologies.

Priority is assigned to emerging technologies that can be deployed in new buildings or as part of retrofit projects, including residential space- and water-heating systems, lighting, cooling, ventilation and equipment. Activities are cost-shared with key stakeholders in the buildings industry, resulting in substantial leveraging of federal funds by private sector companies, energy utilities, trade associations, universities and provincial governments. Projects include R&D and field trials of emerging technologies, the development of design tools, and technology transfer initiatives.

The BETA Plan encompasses two activities that focus directly on residential buildings. The Advanced Houses Program features the construction, public demonstration and performance monitoring of 10 houses across Canada that use one quarter of the energy of conventional homes. Building systems and indoor environment activities support the development of advanced building-design tools and heating, ventilation and space-conditioning systems.

The BETA Plan provides industry and other government programs with technical support and advice to accelerate the adoption and application of energy efficiency in build-


The Advanced Houses Program features the construction, public demonstration and performance monitoring of 10 houses across Canada that use one quarter of the energy of conventional homes.

ings. Activities include monitoring building performance, collecting energy-use and environmental impact data for both conventional and innovative buildings, and giving technical advice for other residential building initiatives, such as the R-2000 Home Program and energy utility demand-side management programs.

Achievements in 1994-95

- All 10 Advanced Houses completed their one-year public demonstration period, attracting national media coverage, and eight have been sold and occupied. Detailed performance monitoring of all houses is under way. All 10 houses are expected to reach their targets of one-half the energy consumption of similarly sized R-2000 houses and to meet the indoor air-quality requirements established by Health Canada.
- Industry adoption of Advanced Houses technologies continues to be strong. The R-2000 Home Program has upgraded its technical requirements, partly in response to the success of the Advanced Houses. Local builders are working with Clayton Developments, builder of the Nova Scotia Advanced House "Envirohome", to build a series of energy-efficient, environmentally responsible houses for which there is a strong consumer market. In addition, the Canadian Home Builders' Association and Canada Trust established an Envirohome Program, which provides mortgages at a reduced rate for houses that approach Advanced House standards.
- The Advanced Houses workshops for builders and professional groups attracted large audiences in Canada and the United States.
- Officials from CANMET, the Department of Foreign Affairs and International Trade, the National Research Council, Industry Canada and the Canadian Manufactured Housing Association visited Japan to discuss adapting Canadian Advanced House technology to Japanese needs.

- CANMET created new computer software for home audit and home energy rating. The AUDIT 2000 program, the first of its kind, can be used to perform energy audits on homes and recommend energy-use improvements. AUDIT 2000 is scheduled to go on sale in the summer of 1995 to meet a strong demand from provincial energy utilities and the U.S. market.

Buildings Energy Technology Advancement (BETA) Plan — Large Buildings

Purpose

To support the building industry's efforts to develop, commercialize and adopt energy-efficient and environmentally responsible technologies for large buildings.

Activities

Innovative energy-efficient technologies and practices could reduce energy consumption in commercial and multi-unit residential buildings by up to 60 per cent. The BETA Plan is working to meet this long-term goal. The plan includes a wide range of technology development, technology transfer and quality assurance initiatives designed to assist the commercial and high-rise residential buildings sector improve its energy and environmental performance. Activities are designed to address the technology and information gaps that inhibit the adoption of energy-efficient technologies. They include the C-2000 Advanced Buildings Program and building systems and indoor environment activities. Projects are conducted in close cooperation and on a cost-shared basis with the buildings industry, other federal departments, provincial governments and energy utilities.

The C-2000 Program is accelerating the adoption of emerging technologies by demonstrating that commercial and high-rise residential buildings can be more energy efficient, have better indoor environments, and have less effects on the environment. C-2000 environmental criteria include curbing CO₂ emissions

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The C-2000 Program is accelerating the adoption of emerging technologies by demonstrating that commercial and high-rise residential buildings can be more energy-efficient, have better indoor environments, and have less effects on the environment.

and use of technologies that do not use chloro-fluorocarbons (CFCs). Several advanced energy-efficient commercial buildings will be constructed across Canada, funded jointly by a wide range of energy and building industry stakeholders.

Building systems and indoor environment activities focus on the development of energy-simulation tools for industry, and on analysis and assessment of innovative space conditioning techniques, ventilation equipment, lighting, office equipment and building assemblies.

In addition, the program provides technical support for the application of advanced technologies in other federal, provincial or utility-led programs that affect large buildings.

Achievements in 1994-95

- CANMET signed an \$800 000 agreement with 13 federal and provincial government agencies and energy utilities from across Canada to form the Canadian Consortium for Building Energy Compliance Software. The consortium is pooling resources and expertise to develop a software package that will assess the energy performance of commercial buildings. The functions of this software will be to support energy-utility demand-side management programs, building-labelling programs and building research, analysis and design, and to check compliance with the *National Energy Code for Buildings*.
- CANMET launched several collaborative C-2000 building projects that will adhere to C-2000 performance criteria and will be designed with technical support from the C-2000 Program. Limited funding will be available for some of the more innovative aspects of these designs. Projects include:
 - an office building in Victoria's Parliamentary Precinct, with funding from B.C. Buildings Corporation and B.C. Hydro; and

- a Winnipeg office building to house several public and private non-profit agencies in the energy and environmental fields.

- Under the IDEAS Challenge, CANMET and CMHC sponsored a national high-rise apartment design competition that received 26 design submissions from across the country. IDEAS offers financial support to teams of architects, engineers, building scientists and developers to produce innovative designs for residential buildings of five storeys or more. Five teams from Victoria, Edmonton, Toronto, Montreal and Halifax were selected to receive funding to finalize their designs.

- CANMET reached a two-year joint agreement with the Royal Architectural Institute of Canada to publish *Advanced Buildings*, a bimonthly newsletter on R&D in the large buildings field. The newsletter is partially supported by subscriptions and is distributed throughout North America.

- Four projects were selected through a competitive process and have gone on to participate in the "Concept Design Phase" of the C-2000 Program. To be designated C-2000, the buildings must meet rigorous design criteria in the areas of energy efficiency, environmental impact, occupant comfort, functionality, adaptability and longevity. The projects include:

- a two-building office complex in Richmond, B.C., proposed by Bunting Coady Architects and Bentall Development Inc.;
- a new municipal office building for the Town of Banff, proposed by the Town and TransAlta Utilities;
- a small two-storey office building in Waterloo, Ontario, proposed by Enermodal Engineering; and
- the retrofit of an office building in Halifax, proposed by Rose Technology group and Nova Scotia Power.

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design criteria in the
areas of energy
efficiency,
environmental
impact, occupant
comfort,
functionality,
adaptability and
longevity.

Buildings Energy Technology Advancement (BETA) Plan — Passive Solar Buildings

Purpose

To develop, commercialize and encourage the adoption of passive solar technologies for residential and commercial buildings.

Activities

The BETA Plan's Passive Solar Program helps Canadian innovators develop and deploy technologies that increase the use of passive solar energy in buildings. Activities include high-performance and advanced window R&D, support for adoption of efficient windows in the marketplace, commercial building applications such as daylighting and system integration, and passive solar modelling. Projects range from technology and product standards development and technology assessment to technology transfer and quality assurance.

Activities are cost-shared with industry, mostly small and medium-sized enterprises, and organizations, including universities, trade associations, research councils, energy utilities and other departments at all levels of government. Overall, federal funds have been matched by program participants.

A major thrust of the program is to promote the deployment of technology through the development of a window labelling program and product and installation standards. This will help the industry supply the residential retrofit market more effectively with high-performance window products. Support is also provided for the development of super-high-performance windows, which further enhance the energy performance of the market's best designs, and for ultra-advanced windows based on emerging technologies such as electrochromics or aerogels. The development of computer simulation and design software and window durability test methods are other key areas of activity.

Achievements in 1994-95

- CANMET continued to work with the Canadian Window and Door Manufacturers'

Association to support its Window Certification Program. The first certified products list containing more than 100 products has just been issued. Continuing cooperative research projects are expanding the CSA A440.2 window energy-performance standard to similar products, such as skylights. Window-installation standards are also being developed, and design issues such as condensation and low-temperature air-leakage are being addressed. An extensive research project relating to durability of insulating glazing units has just been completed.

- CANMET completed research on daylighting systems and design tools, including extensive analyses of three buildings, and found that problems in design implementation and building operation were compromising energy efficiency. This research was used in an update of the Illuminating Engineering Society handbook chapter on daylighting design.
- CANMET developed a technical standard for door energy performance. This new standard, together with the A440.2 window energy-performance standard, are included in the new *National Energy Code for Houses*. The code will provide for windows of approximately double the energy efficiency of windows now coming on the market.
- Technology transfer in support of high-performance windows included technical support for an NRCan consumers' guide, a window and door utility guide being developed with the Canadian Electrical Association, and a book on Canadian solar houses being developed with CMHC.
- CANMET completed new versions of the VISION and FRAME software programs, the best window-design applications available, which allow manufacturers to simulate energy performance and condensation resistance.

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*The BETA Plan's
Passive Solar
Program helps
Canadian innovators
develop and deploy
technologies that
increase the use of
passive solar energy
in buildings.*

Heat Management Research and Development

Purpose

To help Canadian companies develop, commercialize or acquire heat management technologies to improve their energy and environmental performance and their competitiveness.

Activities

The residential, commercial and industrial sectors have considerable potential for energy-efficiency gains through the application of advanced heat management technologies. CANMET's Energy Diversification Research Laboratory (EDRL) in Varennes, Quebec, delivers the Heat Management R&D Program, which develops and promotes the application of advanced heat management technologies, including advanced heat pumps, heat storage and heat exchangers; energy management control systems; modelling and simulation of equipment and processes; and optimization of equipment, systems and process application.

The program supports the development and commercialization of innovative heat management technologies in a variety of ways, including: applied in-house R&D on specific technologies; participation in cost- and task-shared R&D projects with industry, universities, research organizations or other government departments; and provision of laboratory and technical services on a cost-recovery basis.

The program's three-element strategy increases the application of advanced technologies by:

- working closely with Canadian heating, air conditioning and refrigeration equipment manufacturers to help them identify technology gaps and develop competitive energy-efficient technologies;
- cooperating with consulting engineers in technology evaluation and technology transfer to raise their awareness of advanced technologies entering the marketplace; and

- encouraging deployment of advanced technologies to commercial and industrial end-users through R&D, technology transfer and links with technology suppliers.

Achievements in 1994-95

- EDRL completed the second year of a five-year, \$2-million project to develop a new, energy-efficient, gas-fired absorption heat pump for heating and cooling small commercial buildings as part of an international R&D consortium involving Canadian gas utilities. Commercialization of this heat pump is being investigated by North American manufacturers. This activity also brings valuable absorption expertise to Canada through strategic alliances with foreign research centres.
- With several Canadian partners, EDRL completed the first year of a four-year, \$2-million project to develop a chemical heat pump that will enable a Canadian dairy producer to reduce its operating costs, generate substantial energy savings, and meet its energy-storage requirements.
- EDRL completed the first year of a two-year, \$380 000 project with a large Canadian appliance manufacturer and distributor to develop a new generation of high-performance electrical and gas-fired clothes dryers that would exceed the 1995 Canadian and United States energy-efficiency standards by 15 per cent. In addition, CANMET is negotiating a licensing agreement that will allow the manufacturer to use EDRL software to test and improve its product line. Through collaboration with EDRL, the company aims to double its current production rate.
- With the assistance of EDRL, a Canadian manufacturer of ventilation and heat-recovery systems has started R&D on novel materials for a new, more efficient product line. Other participants in Phase I of this \$400 000 project include INRS-Énergie et Matériaux in Varennes, Quebec, and the Industrial Materials Institute of the National Research Council. When a suitable, low-cost, high-performance material

The residential, commercial and industrial sectors have considerable potential for energy-efficiency gains through the application of advanced heat management technologies.

is found, additional financing will be sought to proceed to Phase II.

- The European Space Agency awarded EDRL a \$100 000 contract to evaluate the potential of advanced heat-pumping technologies in space applications. EDRL's pool of expertise on chemical, absorption and other systems was instrumental in obtaining the contract.
- On behalf of the International Energy Agency Working Party on End-Use, EDRL hosted a workshop on energy-storage options, helped organize the Indoor Air Quality, Ventilation and Energy Conservation in Buildings Conference to be held in Montreal in May 1995, and began to organize two international conferences to be held on advanced energy technologies in Canada in 1996.
- EDRL profited from staff exchanges with industry and universities in Canada and abroad including exchanges with Carrier Corporation in the United States, Technical University of Nova Scotia, Pennsylvania State University and Stork Canada.
- EDRL is bringing into commission a state-of-the-art climatic chamber for testing advanced heat management technologies.



Chapter Five

Energy Efficiency — Equipment

Equipment Energy Use

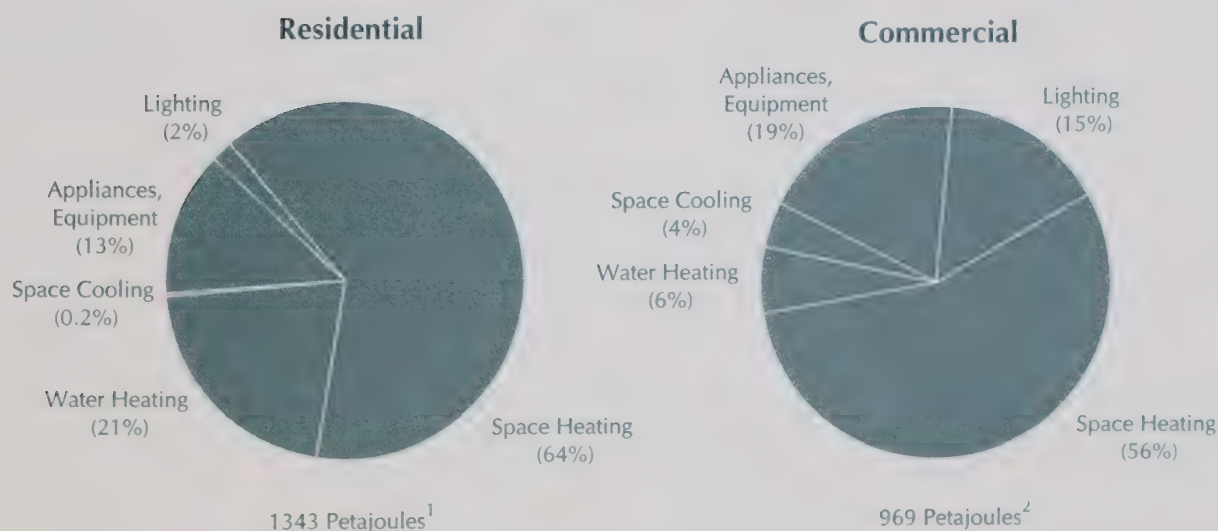
The energy efficiency of a building can be enhanced by improving building design and construction techniques (for example, by increasing insulation and airtightness); the efficiency of its equipment, such as furnaces and air conditioners; and the energy practices of the occupants — their equipment operation and maintenance habits. This chapter focuses on energy-using equipment.

Energy-using equipment includes:

- household appliances, including refrigerators, freezers, dishwashers, ranges, clothes washers and clothes dryers;
- water heaters;
- lighting fixtures, including lamps and ballasts;
- space-heating and -cooling equipment, including furnaces, electric heaters and air conditioners;
- commercial refrigeration units, such as those used in supermarkets; and
- motors, such as those used in the industrial sector.

Figure 5.1 provides a breakdown, by equipment category, of residential and commercial

Figure 5.1
Residential and Commercial Energy Use by End Use, 1993



1. Excludes farm motive use.

2. Excludes aviation fuels, motor gasoline and diesel fuel oil from non-public administration.

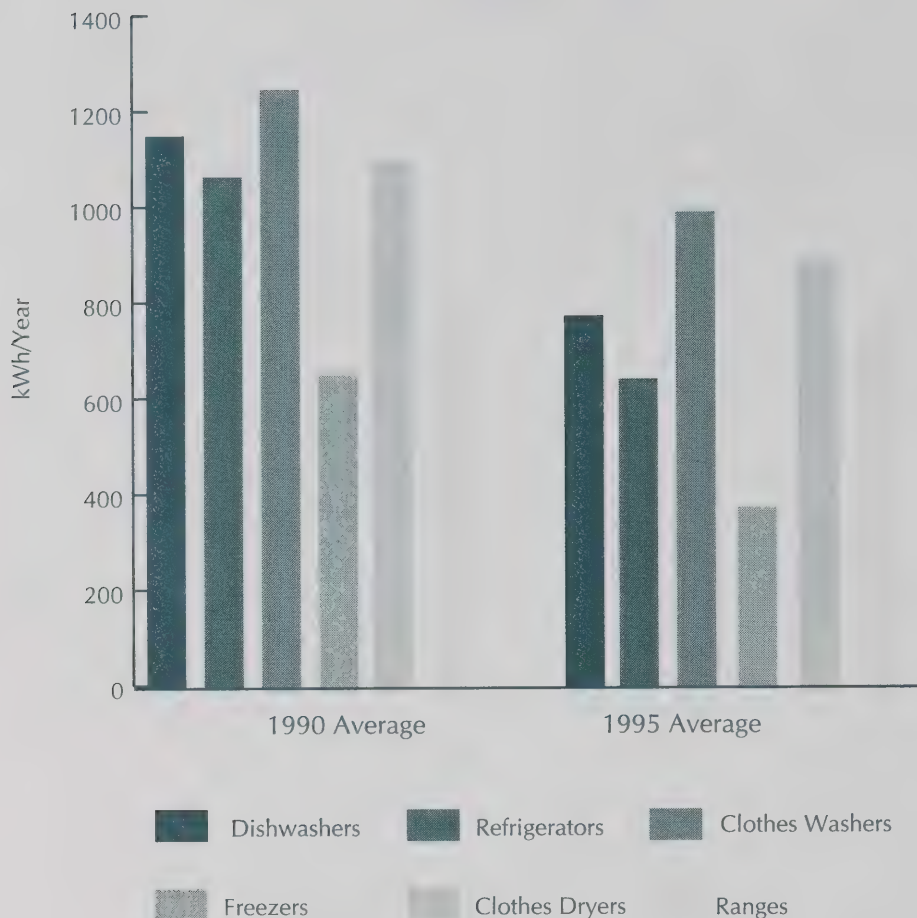
Sources: NRCan, Residential End Use Model.

NRCan, Commercial End Use Model.

Statistics Canada, "Quarterly Report on Energy Supply-Demand in Canada,"

Cat. no. 57-003, 1993-IV.

Figure 5.2
*Trends in Appliance Energy Use in Canada,
1990 and 1995*



Notes: Based on typical appliances in terms of features. Energy consumption for dishwashers and clothes washers includes the energy required to heat the water.

Source: NRCan, EnerGuide Program.

In the residential sector, significant energy-efficiency gains have been achieved for five of the six major appliances since 1990.

energy use. Space-heating accounts for the largest share of energy use in both sectors — about 64 per cent in the residential sector and about 56 per cent in the commercial sector.

In the residential sector, water-heating accounts for the second largest share (21 per cent) of energy use, followed by appliances (13 per cent). Space cooling and lighting account for only a tiny portion of residential energy use.

In the commercial sector, appliances (19 per cent) and lighting (15 per cent) are

the second- and third-largest energy end-uses. Water heating and space cooling together account for only 10 per cent of commercial energy use.

Developments in Energy Efficiency

In the residential sector, significant energy-efficiency gains have been achieved for five of the six major appliances since 1990. Figure 5.2 compares average energy-use ratings (in kilowatt-hours annually) for

typical new appliances, based on EnerGuide data for models sold in Canada in 1990 and 1995. Between 1990 and 1995, the most significant improvement in energy efficiency — 43 per cent — was achieved with freezers. Similarly, the energy-efficiency of refrigerators improved by 40 per cent. However, over the same period, the size of a typical refrigerator increased about 6 per cent, offsetting gains in energy efficiency somewhat.

Other notable improvements in energy efficiency were achieved for dishwashers (33 per cent), clothes washers (21 per cent) and clothes dryers (19 per cent). Only a marginal improvement (4 per cent) was realized for electric ranges and ovens.

Significant energy-efficiency gains have also been realized in natural gas space-heating. In 1990, approximately 63 per cent of the natural gas furnaces sold were conventional, with annual fuel-use efficiencies

around 65 per cent. Since 1992, however, manufacturers have phased out conventional gas furnaces and now produce only mid- and high-efficiency units, with efficiencies ranging from 78 per cent to more than 90 per cent.

In the commercial sector, energy intensity has continued to improve over the past five years. However, decreases in commercial sector energy intensity have been offset to some extent by greater market penetration of electronic equipment, such as facsimile machines, computers and photocopiers. Furthermore, greater use of space-cooling equipment has increased electric energy use.

Energy Performance Regulations and EnerGuide

Descriptions and achievements of these two programs are provided in chapter two.

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Chapter Six

Energy Efficiency — Industry

Industrial Energy Use

The Canadian industrial sector comprises manufacturing, mining and forestry activities. Industrial energy use includes energy use by the process-specific technologies within each industry, such as a pulp refiner, a cement kiln or a blast furnace, and all energy use for operating auxiliary devices. Such applications include steam generation and pumping or compression. Other industrial uses are lighting, heating, ventilation and air conditioning.

Table 6.1 shows that, in 1993, industrial energy use¹ amounted to 2426 PJ or 35 per cent of Canada's total secondary energy use.

Table 6.1 also shows that this energy use is concentrated; just three industries — pulp and paper, mining, and iron and steel — account for more than one half of industrial energy use.

Figure 6.1 shows secondary energy use by energy type in the industries that consume the most energy. The three major energy sources used by industry are electricity, natural gas and refined petroleum products. The pulp and paper industry also consumes large amounts of hog fuel² and spent pulping liquor,³ and the iron and steel industry is a significant consumer of coking coal and coke-oven gas.

¹ This energy use is for the entire industrial sector and, therefore, includes sectors that do not participate in the Canadian Industry Program for Energy Conservation.

² Hog fuel consists of pulverized bark, shavings, sawdust and low-grade lumber rejected by pulp mills, saw mills and plywood mills.

³ Spent pulping liquor is a substance primarily made up of lignin, other wood constituents and chemical byproducts of the manufacture of chemical pulp. It can be used in a boiler to produce steam or electricity.

Table 6.1
Industrial Energy Use by Sector, 1993

Industry	Petajoules	Per cent
Pulp and Paper	769	31.7
Iron and Steel	245	10.1
Mining	307	12.6
Chemicals	228	9.4
Smelting and Refining	219	9.0
Petroleum Refining ¹	72	2.9
Cement	45	1.8
Construction	33	1.4
Forestry	13	0.5
Other Manufacturing	497	20.5
TOTAL	2426	100.0

1. In accordance with Statistics Canada's definition of the industrial sector, petroleum refining producers' consumption of refined petroleum products is not reported as industrial sector final demand. Including this consumption would increase total petroleum refining consumption to about 240 petajoules.

Source: Statistics Canada, "Quarterly Report on Energy Supply-Demand in Canada," Cat. no. 57-003, 1993-IV.

Figure 6.1
Industrial Energy Use by Fuel Type, 1993



1. In accordance with Statistics Canada's definition of the industrial sector, petroleum refining producers' consumption of refined petroleum products is not reported as industrial sector final demand. Including this consumption would increase total petroleum refining consumption to about 240 petajoules.

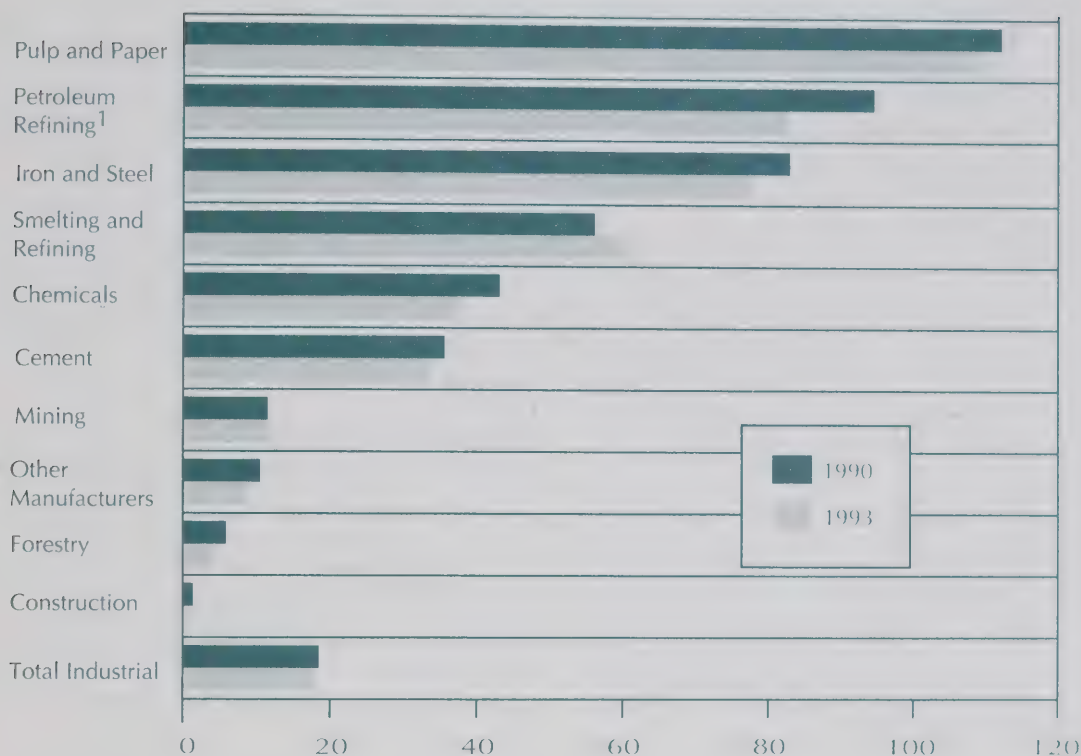
Source: Statistics Canada, "Quarterly Report on Energy Supply-Demand in Canada,"
Cat. no. 57-003, 1993-IV.

Table 6.2
The Importance of Energy Purchases in Selected Industries, 1993

	Total Production Cost (per cent)	Value of Shipments (per cent)
Cement	33.60	17.72
Chemicals	15.69	10.64
Smelting and Refining	14.37	10.85
Pulp and Paper	11.51	9.23
Iron and Steel	9.55	7.71
Petroleum Refining	2.16	1.92
Other Manufacturing	3.00	1.49

Source: Statistics Canada, "Manufacturing Industries of Canada: National and Provincial Areas, 1992," Cat. no. 31-203.

Figure 6.2
Industrial Energy Intensity by Sector, 1990 and 1993



Megajoules of secondary energy per dollar of real domestic product (\$1981)

1. In accordance with Statistics Canada's definition of the industrial sector, petroleum refining producers' consumption of refined petroleum products is not reported as industrial sector final demand. Including this consumption would increase petroleum refining energy intensity to about 360 megajoules per dollar.

Sources: Statistics Canada, "Quarterly Report on Energy Supply-Demand in Canada," Cat. no. 57-003, 1993-IV.
Informetrica Ltd./NRCan, Canada.
Canada's Energy Outlook 1993-2020, October 1994.

Table 6.2 compares energy purchases with total production costs, showing wide industry variation. However, the cost of energy is only one of industry's considerations — and often not the most important one. Although these data do not fully reflect the cost of energy to industrial users in specific sectors, they do show that energy purchases do

not account for a large share of production costs in many industries.

Developments in Energy Efficiency

Industrial energy intensity¹ has decreased considerably since 1985 and, since 1990,

¹ The ratio of energy use to real domestic product, also referred to as energy intensity, is commonly used as a measure of energy efficiency. Although there are few alternatives to this measure at an aggregate level, most experts agree that for specific sectors where quantity measures of output are available, energy per unit of output volume is the preferred indicator. NRCan, Statistics Canada and the Canadian Industry Program for Energy Conservation are currently collaborating to develop data and methodologies for such indicators. It is expected that by the end of 1995-96 such data will be available for reporting through 1994.

continuing efforts by industrial energy users to reduce consumption have helped to limit growth in energy use.

Industrial energy demand remained relatively stable between 1990 and 1993. During the same period, industrial production, measured by real domestic product, grew by 6 per cent. Figure 6.2 shows the result — a 5 per cent decline in industrial energy intensity.

Figure 6.2 also shows that the decline in energy intensity was not concentrated in a few industries. In fact, between 1990 and 1993, energy intensity declined in most sectors that consume large amounts of energy.

Industry strives continually to improve its competitive position, and energy efficiency is one way to achieve this objective. The Canadian Industry Program for Energy Conservation helps government and industry identify opportunities to improve energy efficiency and persuades industry to act on these opportunities.

Industrial Energy Efficiency

Purpose

To increase the efficiency of energy use in Canada's manufacturing, mining and forest products sectors.

Activities

This initiative is based on voluntary action by industry to increase energy efficiency, help to limit emissions and increase economic competitiveness. It includes three interrelated elements:

- the Minister's Advisory Council on Industrial Energy Efficiency (MACIEE);
- the Canadian Industry Program for Energy Conservation (CIPEC); and
- the Industrial Energy Innovators Program.

The MACIEE provides a forum for industry executives to discuss energy-efficiency policy, programs and project implementation with the Minister. The MACIEE meets at least annually to review progress and oppor-

tunities for Canadian industry to become more energy efficient. It encourages industry executives to support and implement more efficient energy use.

CIPEC provides a sector-level focus for industry to identify and set energy-efficiency targets and to develop and implement plans to achieve these targets.

The Industrial Energy Innovators Program recruits and encourages industrial energy users to develop long-term energy-management planning and replication strategies for their companies.

Achievements in 1994-95

- With seven new members (for a total of 18), the MACIEE now represents almost 90 per cent of industrial energy end-use in Canada.
- At the second MACIEE meeting, on October 29, 1994, the Minister received the commitment of the manufacturing industries to develop energy-efficiency targets to limit their CO₂ emissions.
- CIPEC published its first annual report documenting industrial energy use from 1990 to 1992. Despite relatively stable energy use, participating industries posted a 1 per cent reduction in annual CO₂ emissions for each year during this period.
- To help refine the overall energy-efficiency objective set by the MACIEE and develop plans to achieve it, industry committed to work with NRCan to define the potential for industrial energy efficiency at the sectoral level.
- With Statistics Canada, NRCan and CIPEC began to develop a system for tracking and reporting sector-level industrial energy-efficiency improvements. Eventually, this will enable companies to compare energy-efficiency performance with their peers.
- The number of active CIPEC sectoral task force working groups increased from one to nine. Each working group develops energy-efficiency objectives and plans for its sector.

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The Minister's

Advisory Council on

Industrial Energy

Efficiency provides a

forum for industry

executives to discuss

energy-efficiency

policy, programs

and project

implementation with

the Minister.

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*Energy-management
training is a key
component of
NRCan's industrial,
commercial and
institutional
initiatives.*

- NRCan launched a process to develop a comprehensive investment-analysis guide for financing industrial energy-efficiency opportunities in Canada.
- The department developed an Industrial Energy Management Opportunities Workshop for maintenance personnel, plant engineers, energy managers and other plant energy personnel in small and medium-sized companies. The workshops will be delivered through the Canadian Energy Management and Environmental Training initiative as part of task force action plans and as stand-alone offerings.

Canadian Energy Management and Environmental Training

Purpose

To provide energy users with opportunities for comprehensive energy-efficiency and environmental training.

Activities

The Canadian Energy Management and Environmental Training (CEMET) Program provides training for the industrial, commercial, educational, governmental and institutional sectors. CEMET operates through 30 community colleges and CEGEPs, providing needs analysis services, competency-based evaluations, training materials, course design and delivery, and evaluation. Energy-management training is a key component of NRCan's industrial, commercial and institutional initiatives.

Achievements for 1994-95

- In helping clients plan energy-efficiency programs, CEMET:
 - developed a long-term, energy-efficiency planning workshop for the industrial and buildings sectors; and
 - developed an industrial and commercial energy-efficiency training catalogue in both printed and electronic forms.
- In helping clients identify energy-efficiency opportunities, CEMET:
 - developed an industrial energy-efficiency opportunities workshop for small and medium-sized businesses;
 - developed a technical advances workshop on energy-efficient technologies for the retail, hospitality and institutional sectors;
 - completed a study of the plastics industry, identifying the knowledge and skills required to ensure efficient use of energy;
 - in cooperation with the renewable energy industry, developed renewable energy awareness materials designed to increase knowledge and understanding;
 - produced five case studies demonstrating training pay-off in the buildings sector; and
 - with Environment Canada, developed a water-saving opportunities workshop manual and software.
- In helping clients implement training, CEMET:
 - developed an integrated training strategy and supplied products and services for the Federal Buildings Initiative to help establish training programs in all FBI projects;
 - in December 1994, trained facility operators from the Harry Hays Building, Calgary, Alberta, at the Southern Alberta Institute of Training, as a pilot for the Federal Buildings Initiative;
 - gave Energy Auditing and Boiler Plant Systems training through St. Clair College to 26 Labatt Brewery employees at the request of the Chairman of the Brewers Task Force of CIPEC; and
 - trained 294 students at CEMET courses, including electrical opportunities workshops, given by colleges in the CEMET network and by energy utilities.

Industry Energy Research and Development

Purpose

To encourage industry to develop new technologies that can decrease energy consumption and environmental impact.

Activities

The Industry Energy Research and Development (IERD) Program supports the development and use of new energy-efficient processes, products, systems and equipment proposed by industry. Projects contribute to a cleaner environment and help Canadian companies increase their share of domestic and foreign markets. The technologies developed can be applied in any energy end-use sector — not only in industry but also in the transportation and buildings sectors.

The cost of technology development is shared with industry and other project participants. The average level of IERD contribution is about 35 per cent of total project costs, although funding can increase to a maximum of 50 per cent, depending on technical risk, potential energy savings, and the degree to which the technology could improve Canada's economic competitiveness. Projects are reviewed and recommended by the IERD Advisory Board, which comprises representatives from several federal departments, including Industry Canada, the National Research Council, Environment Canada and Transport Canada.

Clients of this program range from innovative small and medium-sized R&D companies striving to carve out market niches to Canadian divisions of multinationals competing for product mandates within their firms. The program forges links between technology developers and end-users to encourage the widest possible application of technologies. It also promotes the formation of research consortia to accelerate the development and commercialization of technologies. Technology transfer, a major component of the program, ensures broad dissemination of advances in technology and knowledge and

provides focused monitoring during development.

Achievements in 1994-95

- A \$3-million radio frequency/vacuum (RF/V) kiln developed with the Council of Forest Industries of British Columbia was recently licensed for manufacture by Salton Fabrication Ltd. of Vancouver. The RF/V kiln performs drying and pasteurizing operations at 70 per cent energy efficiency (conventional kilns operate at only 20 per cent energy efficiency) in a fraction of the time required by conventional kilns.
- With IERD funding, Norvik Traction Inc. of Mississauga, Ontario, developed a fast battery charger for electric vehicles. One is now being used in a CANMET project with Inco Ltd. to recharge a Chrysler Corporation electric van. The technology can be used with other types of batteries, including those used in video camcorders and electric wheelchairs.
- With IERD funding, GE Canada undertook risky, long-term R&D to become the worldwide GE Centre of Excellence for large, rotating machines. Subsequently, GE Canada went on to win world product mandates for large electric motors, hydro generators and turbines, and traction motors for locomotives.
- IERD provided technical and financial support to Imperial Oil Ltd. in the development of new engine and drive-train lubricants and diesel fuel formulations to improve the energy efficiency of heavy-duty on- and off-road transport vehicles. One result of this effort was the naming of the Imperial Oil Research Centre in Sarnia, Ontario, as the Centre of Excellence responsible for all of Exxon's and Imperial's North American lubricant-product R&D, including the formulation of the more than 1000 lubricants now in production.
- With support from IERD, Zimmark Inc. of Burlington, Ontario, has developed a technology to recover and reuse lubricating oil from locomotive engines, which is

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*Industry Energy
Research and
Development
provided technical
and financial support
in the development of
new engine and
drive-train lubricants
and diesel fuel
formulations.*

much more energy efficient than alternative ways of producing this product. The recycled oil meets stringent quality standards. CN now has six sites recycling 1.5 million litres of oil a year. CP has two sites, at which 0.5 million litres of oil are recovered each year. In addition, Zimmark has five sites in the United States, two in China, one in the Philippines, and one in Malaysia, recovering a total of 2 million litres of oil each year.

- With support from IERD, Stackpole Limited of Toronto has emerged as a world leader in the manufacture of high-quality low-cost automotive parts using powder metallurgy. The company is continuing to expand its range of products and is now supplying them to Ford, GM and Chrysler.

- A joint project with Ontario Ministry of Environment and Energy and Ontario Hydro resulted in a successful field trial of a prototype VAR compensator at Monroe Automotive in Owen Sound, Ontario. This unit, manufactured by Trench Electric, not only saves electricity, but also extends the life of a wide range of electrical equipment in the plant. Total annual energy savings are in excess of \$100 000, resulting in payback in less than one year. Six other units have been sold in the United States. The VAR compensator helps reduce the need for additional power generation and improves power quality.

Industrial Targeted Technologies Program

Purpose

To identify emerging energy-efficient technologies and development opportunities that will decrease industry's energy use, improve its manufacturing competitiveness and reduce its environmental impact.

Activities

The Industrial Targeted Technologies Program (ITTP) identifies technical barriers to increasing the energy efficiency of Canadian

industries and supports the development and implementation of technological solutions that contribute to a cleaner environment, improved productivity, better products, reduced waste and a stronger market position for Canadian companies. In particular, the program focuses on energy-efficient technologies that offer the highest rate of return on R&D investment for Canada's industrial sector.

The program identifies R&D opportunities in specific sectors and conducts technology assessments of these opportunities. This involves describing technologies, potential energy benefits, state of development, environmental impacts, potential market penetration, and barriers to, and economics of, implementation. Technology development projects are subsequently launched in partnership with industry.

Clients include the pulp and paper, iron and steel, cement, oil and gas, and food and beverage sectors. Industry sets the strategic direction and ITTP provides coordination, bringing together interested companies and industrial stakeholders. Activities are developed, managed and funded in cooperation with industry and other partners, including the gas and electric utilities, other governments, and equipment manufacturers.

Achievements in 1994-95

- Lobbe Technologies Ltd. of Regina completed a \$75 000 ITTP-funded assessment of the current application of artificial intelligence systems in the mining and metallurgy, oil and gas, iron and steel, cement, and pulp and paper industries. The advantages of artificial intelligence systems include decreased energy use and costs, reduced environmental impacts, improved productivity and better safety control. B.C. Hydro, Ontario Hydro and Hydro-Québec also funded this study.
- A \$175 000 ITTP-funded full-scale field trial of the combustion of whole tires in a cement kiln was conducted at the St-Constant, Quebec, cement plant of La Farge Canada Inc. Because this project

was successful, the company obtained approval from Quebec environmental authorities to burn tires continuously in the kiln. The Government of Quebec and Environment Canada helped fund this project.

- ITTP provided \$100 000 in funding to Goodfellow Consultants Inc. of Mississauga, Ontario, to design and install an electric-arc furnace fume-control system for Co-Steel Lasco of Whitby, Ontario. An expert computer system is being developed to optimize the air pollution control system. The ITTP funding is being matched by the Ontario Ministry of Environment and Energy.
- ITTP provided \$200 000 in funding for development and implementation of a solvent vapour recovery and reuse system for a co-polymer process for a medical glove manufacturer at Bridgewater, Nova Scotia. ECI Medical Technologies Inc. of Richmond Hill, Ontario, has the world mandate for this process, and anticipates a significant export market.

Advanced Technologies for Process Optimization and Control

Purpose

To help industrial and energy-utility companies reduce their energy use and improve the quality of their products.

Activities

Optimizing energy-intensive processes could reduce primary energy demand in the industrial sector by approximately 15 per cent.

CANMET's Combustion Research Group at ERL develops and supports the adoption by industry of state-of-the-art control technologies, such as expert systems, artificial intelligence, and advanced computational modelling and related processes. Although process-control technologies offer companies immediate opportunities to save energy,

process-design changes are needed to achieve a significant reduction. The group is a member of various consortia of users, technology developers, fuel producers, universities and specialized R&D organizations.

Achievements in 1994-95

- CANMET helped a small Canadian company develop a computer model for combustion applications, which is now being marketed abroad.
- Advanced models developed by CANMET were used to modify a Canadian carbon black producer's natural gas-based process, leading to increased profits, energy efficiency and product quality.
- Several industrial and energy-utility companies used expert systems and advanced computational models developed by CANMET to improve heat transfer and boiler control, reduce NO_x emissions and, in some cases, switch from coal to natural gas.
- In partnership with a Canadian boiler manufacturer and a Canadian electricity utility, CANMET developed an expert system for boiler soot-blowing, thereby increasing boiler efficiency and reducing down-time.

Minerals and Metals Technologies

Purpose

To help Canada's minerals and metals industries improve energy efficiency and reduce energy costs.

Activities

Many of CANMET's research projects in minerals and metals technologies promote the use of recyclable materials or improve or eliminate industrial processes that use a lot of energy. Activities include cost-shared technology development and pilot-scale demonstration projects with industry that also focus on information dissemination, technology transfer and product commercialization.

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Many of CANMET's research projects in minerals and metals technologies promote the use of recyclable materials or improve or eliminate industrial processes that use a lot of energy.

EDRL's Gas Technologies Program emphasizes the development of advanced technologies for energy-efficient industrial processes, gas-fired environmental technologies and gas storage.

For example, CANMET undertakes joint research projects with Canadian foundries and performs energy audits to show where they can save energy and raw materials. A 1 per cent increase in overall yield reduces energy consumption by 1.3 per cent and raw material consumption by 2 per cent. Similar help is available to Canadian mini-mills and steel producers through CANMET's Steel Program.

Other partners include provincial governments and energy utilities, as well as industrial, trade and standards associations.

Achievements in 1994-95

- CANMET established the Mobile Foundry Laboratory Program to perform 20 energy audits each year for the next three years at foundries across Canada. An energy audit has provided one Canadian foundry with \$1.5 million in energy savings to date.
- CANMET developed technology that led to the commercial use of supplementary cementing materials (SCMs) in major building projects, such as the Hibernia offshore oil platform and the Park Lane Shopping Centre in Halifax. The use of SCMs by Canadian cement consumers enables them to reduce their energy use.
- CANMET began to help pilot-test a new microwave technology to replace a conventional hot-air process used by the gold industry to regenerate spent carbon. Preliminary pilot-test results indicate that it could reduce annual operating costs by more than 36 per cent.

Gas Technologies Program

Purpose

To develop natural gas technologies for the Canadian commercial and industrial sectors that will increase energy efficiency, reduce environmental impact, and improve competitiveness.

Activities

In line with priorities identified by its client industries, EDRL's Gas Technologies Program emphasizes the development of

advanced technologies for energy-efficient industrial processes, gas-fired environmental technologies and gas storage. Support for technology development and deployment takes a variety of forms, including in-house, applied R&D on specific technologies; participation in cost- or task-shared R&D projects with industry, universities, research organizations or other government departments; and provision of laboratory and technical services on a cost-recovery basis.

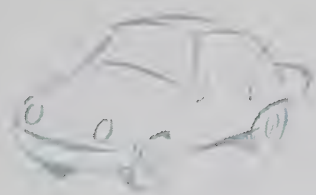
Program clients generally belong to one of three industry groups: gas utilities, small or medium-sized gas equipment manufacturers, and large-scale natural gas users. EDRL seeks to create alliances between these three groups, frequently by organizing multiple-partner research consortia to respond to technology gaps and opportunities and help identify and launch R&D projects.

Achievements in 1994-95

- A small company began to commercialize an improved commercial heating and ventilating appliance that was developed jointly with EDRL. The company's sales have increased by 30 per cent and new jobs have been created.
- With technical assistance from EDRL, a small company demonstrated compliance with environmental standards and avoided a costly shutdown. EDRL's recommendations helped the company avoid a \$700 000 expenditure for a process that would not have met its needs.
- CANMET began work on a \$360 000 research project to develop a gas-fired, pulsed, fluidized-bed dryer in partnership with a Canadian dryer manufacturer and Gas Technology Canada. The new dryer would use half the energy of conventional units, improve drying performance and open the door to new applications.
- CANMET began work on a waste-water treatment R&D project in cooperation with École polytechnique at the Université de Montréal. The aim of the project is to develop an energy-efficient process that uses natural gas to reduce

the concentration of organic contamination in typical industrial waste-water. As on-site treatment of waste-water is becoming mandatory in many jurisdictions, use of this process could have a positive environmental impact. This project, valued at \$310 000, is financially supported by Canadian gas utilities.

- CANMET continued work on a \$355 000 project to bring an energy-efficient grain processor to the pre-commercialization stage in cooperation with Gas Technology Canada and McGill University. The new processor would be twice as energy-efficient and five times more productive than existing grain processors.



Chapter Seven

Energy Efficiency — Transportation

Transportation Energy Use

Energy is used for road, rail, air and water transportation. In 1993, the transportation sector used about 28 per cent of total secondary energy, or 1917 PJ. In the sector, road transportation accounts for about 80 per cent of energy use (1499 PJ), with the remaining demand coming, in descending order, from air, water and rail transportation. As shown in Figure 7.1, gasoline accounts for about 76 per cent and diesel fuel for 22 per cent of total energy use in the road segment, and alternative fuels, such as propane and compressed natural gas, account for the remaining 2 per cent.

Gasoline consumption in the road segment is almost exclusively attributable to light-duty vehicles (LDVs): cars use 66 per cent, light trucks (trucks weighing less than 3864 kg) use about 29 per cent, and medium

and heavy trucks use about 5 per cent (see Figure 7.2). However, heavy trucks account for most diesel use. LDVs continue to be very small consumers of road diesel.

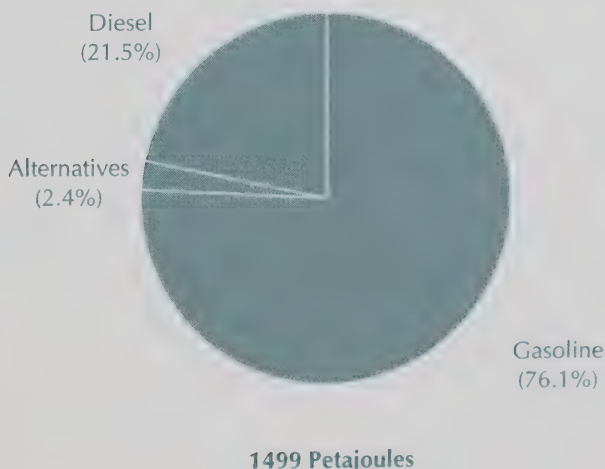
Developments in Energy Efficiency

In 1993, Canada's LDV fleet comprised about 15.5 million vehicles, of which 72 per cent were cars and 28 per cent light trucks. This represents an increase since 1990 of almost 5 per cent in the total number of vehicles and a shift of three percentage points from cars toward light trucks. This trend results partly from the decline since 1990 in the proportion of cars in LDV sales from 72 per cent to 70 per cent.

Although the shift from cars to light trucks in the stock and sales of LDVs suggests a

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In 1993, the
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secondary energy.

Figure 7.1
Road Sector Energy Demand by Fuel, 1993



Sources: Statistics Canada, "Quarterly Report on Energy Supply-Demand in Canada,"
Cat. no. 57-003, 1993-IV.
NRCan, Transportation Energy Demand Model.

deterioration in the average efficiency of LDVs in Canada, manufacturers have been able to improve the efficiency of the largest cars by about 3 per cent, thereby maintaining the average LDV unit consumption. This was accomplished despite an increase in vehicle power.

Voluntary targets for company average fuel consumption (CAFC) have been in effect in Canada since 1978. On average, motor vehicle manufacturers have met or exceeded the program targets for cars in every model year. According to CAFC ratings, new cars sold in Canada in 1993 averaged 8.0 L/100 km, down from 8.2 L/100 km in 1990, exceeding in both years the target level of 8.6 L/100 km. The light-truck program targets, which took effect for the 1990 model year, have also been met for each model year. The CAFC ratings of new light trucks sold in Canada in 1993 averaged 11.3 L/100 km, compared with the 1990 figure of 11.4 L/100 km, marginally better than the target level of 11.5 L/100 km.

For several reasons, the fuel efficiency of new LDVs sold in Canada in recent years has improved little. First, from the consumers' perspective, the softening of real gasoline prices since 1990 and the continued increase in vehicle prices have reduced the importance of fuel cost as a share of the total cost of vehicle ownership. This is reflected in industry surveys, which indicate that fuel efficiency is decreasingly important to consumers in the purchase of new LDVs.

While the relative importance of fuel costs declines, consumers are demanding better vehicle power and performance than ever. In fact, the average horsepower of new cars has increased by 9 per cent since 1990, while the power-to-engine-size ratio has improved by 5 per cent.⁵ These developments are important to the state of fuel

efficiency, as they negatively affect the average level of efficiency of new vehicles. This occurs because available technologies can be used to enhance vehicle power and performance or to improve fuel economy.

For example, producing a lighter aluminum engine of the same size and horsepower will increase performance because the same power is available to move a lighter vehicle. On the other hand, this technology could be used to improve fuel economy if combined with a slightly smaller and less powerful engine. The original performance of the engine would thus be maintained and fuel economy improved by the reduction in vehicle weight.

For manufacturers, meeting consumer desires is a major objective. Manufacturers have, therefore, been offering consumers the power and added comfort they demand. Only a few of the companies that sell LDVs in Canada, however, sell enough larger vehicles to have sales constrained by the CAFC standards.

As the North American automobile market is highly integrated, the fuel efficiency of new vehicles in Canada is heavily influenced by regulatory developments in the United States. The Canadian targets mirror U.S. requirements, which have remained equivalent to 8.6 L/100 km since 1985.

Motor Vehicle Fuel Consumption Program

Purpose

To work with manufacturers to improve motor vehicle energy efficiency and inform purchasers of new cars, light trucks and vans about vehicle fuel consumption rates.

Activities

The federal government administers the Motor Vehicle Fuel Consumption Program

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*On average, motor
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for cars in every
model year.*

⁵ Since 1990, power-to-weight and power-to-engine-displacement ratios have continued to increase, although the average weight of newly purchased LDVs is up by about 2.7 per cent. Although the average new LDV weighs slightly more, fuel efficiency has remained fairly constant.

and publishes and distributes the annual *Fuel Consumption Guide*. The program monitors compliance with CAFC targets for new vehicles to ensure Canadians have access to fuel-efficient cars and light trucks. As part of the program, manufacturers apply fuel-consumption labels to new vehicles to help consumers compare fuel consumption between models. The *Fuel Consumption Guide* complements these activities by providing fuel-efficiency information on all new cars and light trucks.

Transport Canada is responsible for the administrative aspects of the program, such as collecting data from companies and setting guidelines for fuel-consumption test procedures. NRCan is responsible for studying and recommending new fuel consumption targets, and providing consumer information through public education programs such as the *Car Economy Book*. Both departments fund the publication of the *Fuel Consumption Guide*.

Achievement in 1994-95

- In the fall of 1994, as input to the Task Force on Cleaner Vehicles and Fuels set up by the Canadian Council of Ministers of the Environment, NRCan provided advice and a report reviewing the Canadian and U.S. approaches to fuel-efficiency improvement.

Transportation Energy Efficiency

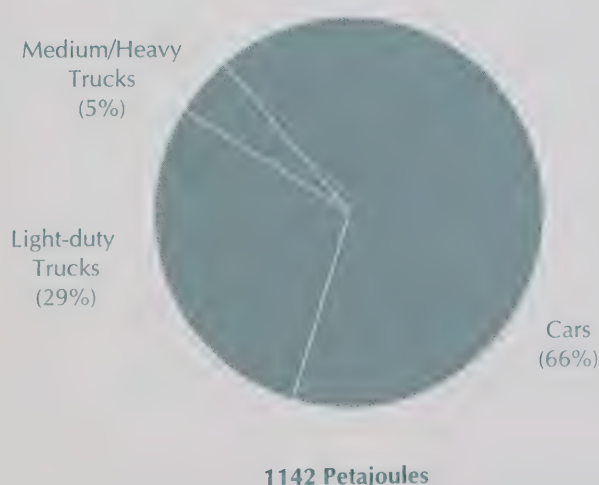
Purpose

To promote energy efficiency in the Canadian transportation sector.

Activities

NRCan promotes energy efficiency and reduced vehicle emissions in the transportation sector through a variety of demonstration, technology-transfer and information programs.

Figure 7.2
Road Sector Motor Gasoline Demand
by Vehicle Type, 1993



Sources: Statistics Canada, "Quarterly Report on Energy Supply-Demand in Canada," Cat. no. 57-003, 1993-IV.
NRCan, Transportation Energy Demand Model.

The Pro-Trucker Program teaches fleet drivers about energy-efficient vehicle selection, maintenance and driving practices. The program is offered in all provinces except Ontario, where a program is being developed for 1995-96. The cost is shared with the trucking industry and provincial governments, under the guidance of regional advisory committees. NRCan also examines energy-efficiency opportunities within fleet operations through demonstration projects with the private sector. The Auto\$mart Program encourages private motorists to adopt fuel-efficient habits in the purchase, use and maintenance of their vehicles through consumer information materials, an exhibit program and joint initiatives with public and private sector partners.

Achievements in 1994-95

- NRCan launched the Auto\$mart Program in October 1994 and promoted it through print-media advertising and communication activities with private sector partners.
- The department awarded a contract to develop a training package for new drivers.
- Auto\$mart provided technical and financial support to a series of car-care clinics for women and a television series on car care.
- Auto\$mart provided funding for the development of a fully automated ride-share matching system.
- NRCan funded several fleet demonstrations to examine the impact of energy-efficient technologies on fleet operations.
- Pro-Trucker energy-efficiency training was expanded to Alberta. Nationally, over 10 000 drivers have participated in the program to date.
- The 1995 *Fuel Consumption Guide* was published in cooperation with Transport Canada.

Transportation Efficiency Research and Development

Purpose

To support the development and commercialization of vehicle technologies that contribute to reduced fuel consumption and a cleaner environment, and to support Canada's competitive position as a vehicle-component manufacturer.

Activities

The Transportation Efficiency Research and Development Program supports the development of Canadian technologies that can directly benefit fleet operators and automobile manufacturers. R&D is focused on high fuel-efficiency, low-emission technologies, such as combustion and exhaust after-treatment, advanced energy storage systems such as flywheels, and advanced materials and processes for automotive applications.

Technology development support takes a variety of forms, including direct funding and cost-sharing of innovative projects with industry, especially small to medium-sized technology-based companies. The program links technology innovators with other transportation stakeholders to promote formation of research consortia. It also provides technical support for the development of policies and regulations.

Partners in technology development include component manufacturers, fuel suppliers, industry associations, fleet managers, universities, research institutes, original equipment manufacturers and other levels of government. Standards development and technology transfer to promote awareness of technological advances among potential users are other key activities.

Achievements in 1994-95

- CANMET entered into an agreement with Flywheel Energy Systems of Ottawa to develop flywheels, an advanced energy storage system, for motive and stationary applications. Flywheels can be integrated

The Auto\$mart

Program encourages

private motorists to

adopt fuel-efficient

habits in the

purchase, use and

maintenance of their

vehicles.

into hybrid power vehicles, reducing fuel consumption and allowing zero-emission operation over a limited range. An interim project on the design and analysis of a radially integrated flywheel battery was completed, and a project to demonstrate a high-performance composite-flywheel energy-storage system by 1997 was initiated.


- The department provided technical and financial support for several projects to develop advanced materials and processes for automotive applications. Technology development contracts were signed with

Long Manufacturing of Oakville, Powerlasers of Waterloo and Alcan/Karmax of Milton, all in Ontario, and Amptech Corporation of Calgary, Alberta.

- CANMET provided technical and financial support to a project to develop a hydrocarbon-reluctant-type catalytic converter for heavy-duty diesel engines using low-sulphur fuel. Other participants include Engine Control Systems of Newmarket, Ontario, Perkins Diesel Engines of the United Kingdom and the petroleum industry.

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*The department
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Chapter Eight

Alternative Energy —

Alternative Transportation Fuels

Energy Sources

Alternative energy is generally defined as including renewable energy sources, such as biomass, small hydro, solar, wind, geothermal, tidal energy and photovoltaic conversion systems. In addition, the term covers new transportation fuels (such as ethanol from renewable energy sources) and new applications of conventional energy sources (such as the use of propane and natural gas as automotive fuels, and batteries in electric vehicles).

Alternative transportation fuels (ATFs) currently account for about 2 per cent of Canadian transportation energy use. Propane and natural gas are used directly in vehicles either converted or manufactured for their use. Propane supplies 1.6 per cent of the Canadian road transport market, with about 160 000 propane vehicles in operation supported by some 5000 public and 2000 private fuelling stations. There are about 30 000 natural gas vehicles in operation, supported by 120 public and 80 private refuelling stations. There are also 120 natural gas-fuelled public transit buses.

The alcohol transportation fuels, methanol and ethanol, can also be used directly in vehicles. At present, however, ethanol is mainly used as an extender in gasoline blends. There are only about 400 light-duty methanol vehicles in operation. Ethanol blends (10 per cent ethanol) are being marketed in the four western provinces and in Ontario.

Propane

Purpose

To promote the use of propane as a vehicle fuel in Canada.

Activities

NRCan is undertaking two initiatives with Canadian industry to encourage Canadians to buy propane vehicles. Under the first, NRCan works with auto manufacturers to encourage the factory production and availability at car dealers of propane vehicles.

The second initiative is geared to regions of the country that are not well served by ATFs: Quebec and the Atlantic provinces. NRCan is working with Superior Propane Inc. and provincial governments to conduct market demonstrations of light-duty propane vehicles in Quebec, New Brunswick and Newfoundland.

Achievements in 1994-95

- Under an agreement signed by NRCan, the Ontario government, members of the propane industry and Chrysler Canada, Chrysler produced 30 demonstration models of a full-sized propane-fuelled van in the 1995 model year. The van features a revolutionary liquid-fuel injector system, an advanced propane fuel tank and new immersion control systems. Full production of the van for the Canadian market is scheduled for the 1996 model year.
- NRCan signed an agreement with Superior Propane Inc. to begin Phase II of the Newfoundland auto-propane demonstration, which is designed to expand the provincial propane vehicle market from about 200 vehicles to more than 750 by March 1997.
- NRCan signed a similar agreement with Superior Propane Inc. to conduct market demonstrations of light-duty propane vehicles in Quebec and New Brunswick.

Natural Gas

Purpose

To promote the use of natural gas as a vehicle fuel in Canada.

Activities

NRCan offers two programs to develop the Canadian market for vehicles powered by natural gas.

- The Natural Gas Vehicle Program contributes \$500 for each vehicle converted to natural gas, \$1000 toward the purchase of a new natural gas vehicle carrying a vehicle company's warranty, and \$500 toward the purchase and installation of a vehicle-refuelling appliance. Natural gas utilities deliver this program on behalf of the federal government.
- The Natural Gas Fuelling Station Program contributes up to \$50 000 for each new public or private natural gas refuelling facility.

Achievements in 1994-95

- The natural gas programs were renewed in June 1994 for an additional three years until March 31, 1997.
- Funding was provided for 1802 vehicles, 197 vehicle-refuelling appliances and 14 fuelling stations.

Methanol

Purpose

To establish an initial infrastructure of methanol fuelling stations and introduce methanol flexi-fuel vehicles to the marketplace.

Activities

In vehicles specially adapted by manufacturers, methanol can be combined with gasoline in any proportion up to 85 per cent by volume. These vehicles are known as flexi-fuel or variable-fuel vehicles. The Methanol Light-Duty Vehicle Project was set up by industry and government in 1991. It aims to introduce a significant number of these vehicles into areas served by methanol refuelling stations.

The vehicles were demonstrated in British Columbia, Alberta and Ontario. The Canadian Oxygenated Fuels Association (COFA) coordinates the project and promotes the purchase of methanol vehicles and the construction of methanol refuelling stations.

Achievement in 1994-95

- NRCan provided COFA with funding for methanol fuel development. During the year, COFA's work resulted in the sale of approximately 500 new methanol-fuelled vehicles manufactured by Ford and Chrysler.

Ethanol

Purpose

To encourage the production and use of ethanol as transportation fuel, and to further the development of lower-cost ethanol supplies.

Activities

The government's ethanol initiative to encourage the production and use of fuel ethanol was announced in November 1992. This initiative complemented the incentive in the 1992 federal budget to use ethanol as a transportation fuel. This incentive exempts the portion of renewable ethanol in ethanol-gasoline blends from the federal excise tax. Several federal departments are involved in the ethanol initiative, which is coordinated through the Interdepartmental Steering Committee on Ethanol, chaired by NRCan.

In December 1994, the government reiterated its support for the production and use of fuel ethanol by announcing the National Biomass Ethanol Program. This program introduced a \$70-million, government-guaranteed line of credit that will make it easier for manufacturers to obtain private sector financing for ethanol plants, and will also provide a means of rescheduling their long-term debt in the event of financial difficulties. The line of credit is intended to assist ethanol manufacturers should a future government change the excise tax on fuel

In vehicles specially adapted by manufacturers, methanol can be combined with gasoline in any proportion up to 85 per cent by volume.

ethanol. The program will be administered by the Farm Credit Corporation on behalf of Agriculture and Agri-Food Canada.

CANMET sponsors projects to improve the conversion of plentiful and inexpensive cellulosic (woody) biomass to ethanol and value-added chemicals. At present, there are six active projects to develop key process steps, including pilot-scale projects such as Queen's University's new fermentation process and Tembec Inc.'s wood-fermentation process. The intent is to demonstrate technology developed under the program and promote its transfer to the private sector. Completed projects include investigation of ethanol production from waste paperboard by Stake Technology Limited of Norval, Ontario.

The Canadian Forest Service of NRCan is investigating, through its ENFOR program (see chapter nine), the process of developing and testing the technology for establishing willow-energy plantations. Fast-growing trees such as willow make good feedstock for ethanol production.

Achievement in 1994-95

- CANMET analyzed the greenhouse effect of transportation fuels using a computer simulation model. Preliminary results indicate that ethanol blends made from corn and wheat have a slightly lower greenhouse impact than gasoline.

Alternative Transportation Fuels Research and Development

Purpose

To increase the market penetration of ATFs by supporting technology development and innovative technologies that can be marketed internationally.

Activities

The Alternative Transportation Fuels Research and Development program focuses on the development of competitive, energy-efficient and environmentally responsible technologies for gaseous fuels (natural gas and propane), alcohols (ethanol and methanol),

biodiesel and advanced transportation systems (electric vehicles and batteries, fuel cells and hydrogen). The program helps Canadian fuel suppliers and vehicle manufacturers develop innovative technologies for sale in domestic and foreign markets.

CANMET provides technical support and shares costs of activities such as R & D, preparation of technical standards for vehicles and refuelling systems, field trials, and technology transfer within Canada and abroad. Laboratory services in support of cleaner fuels are available at CANMET's Western Research Centre (WRC) in Devon, Alberta, and ERL in Ottawa. Partnerships and consortia with industry form the backbone of the program. Clients include stakeholders in the Canadian transportation and energy sectors; small and medium-sized enterprises concentrating on technology innovation that will allow them to establish market niches; and Canadian divisions of North American original equipment manufacturers. Other partners include industry associations, energy utilities, provincial governments, research organizations, universities and other federal departments.

In addition to technology development, the program promotes the use of ATF technologies with large potential users, including fleet managers and transit authorities, by working directly with them to address their specific technology needs. Field trials that assess technologies, reveal opportunities for improvement and transfer information are a critical step toward commercialization of emerging technologies.

Gaseous Fuels — The automotive industry is preparing to introduce propane- and natural gas-powered vehicles to the market in the 1995-96 model year. Canadian equipment manufacturers and fuel suppliers are vying for opportunities to supply this market with advanced, low-cost vehicle components and fuel-supply technologies. CANMET plays a strong role in developing this fledgling, fragmented industry to the point where a diverse group of players with

common goals are able to form partnerships and R&D consortia to advance technologies to commercialization. Activities include planning and supporting R&D, creating and participating in R&D consortia, participating in the development of standards, technology transfer, and providing technical advice. Several technologies that could reduce the cost and increase the operating range of natural gas vehicles are under development, including lightweight, low-cost, fuel-storage cylinders; natural gas technologies for trucks and buses; fuel-injection systems; and electronic fuel-management systems. Activities in the propane area focus on the development of advanced technologies and technical standards.

Alcohol Fuels — Most of the methanol-gasoline dual-fuelled vehicles made by Chrysler Corporation and General Motors for sale in North America are produced in Ontario. Advanced combustion technologies are being developed to enable a new generation of methanol vehicles to meet ultra-low-emission vehicle standards. These technologies can also be applied to gasoline- and gaseous-fuelled engines, improving their emissions performance. CANMET is working to establish international consortia to enable industry to improve and commercialize these new engine technologies. CANMET is also helping Canadian manufacturers of methanol fuel-dispensing equipment to improve products being exported to the United States.

Advanced Transportation Systems — Hydrogen, battery and fuel-cell technologies represent the zero-emission vehicles of the future. Considerable progress has been made in the development of hydrogen technologies and an infrastructure for non-fossil-fuel hydrogen production for use in transportation applications. Canadian-developed fuel cells are among the most efficient and cost-effective in the world. Advanced technologies for electric vehicles and batteries are developing rapidly. Canada's success is largely owing to the close collaboration in

research between industry, universities and governments. CANMET links organizations with similar R&D mandates and participates as a funding partner in various consortia with industry.

Achievements in 1994-95

- In partnership with the Province of Ontario, Detroit Diesel, Nova Bus of St-Eustache, Quebec, COFA, Environment Canada and Transit Windsor, CANMET completed the final year of a technical field trial of six methanol-fuelled transit buses that was launched in 1991. The buses were in regular service with the City of Windsor transit commission.
- CANMET provided funding, along with General Motors Canada, to Thermotech Engineering of Kingston, Ontario, who completed work on a prototype advanced-plasma ignition system. Thermotech is negotiating the inclusion of this technology in the development of methanol and ethanol engines at the U.S. Southwest Research Institute.
- Launched in 1993 by Ballard Power Systems of North Vancouver, British Columbia, the world's first fuel-cell-powered transit bus completed two years of successful field operation in Vancouver. CANMET was instrumental in initiating and directing the project, and provided technical assistance and funding. In Phase II, now under way, a full-sized bus will go into service in the summer of 1995.
- CANMET initiated and co-sponsored a Reformulated Diesel Fuel Workshop to examine issues and options regarding the introduction of reformulated diesel fuels in Canada. This was done in cooperation with the Canadian Petroleum Products Institute, the Motor Vehicle Manufacturers Association, the Engine Manufacturers Association, Health Canada and Environment Canada.
- CANMET provided technical advice and financial support to Ontario Hydro, who launched an evaluation and demonstration of a solid-oxide fuel cell. Other part-

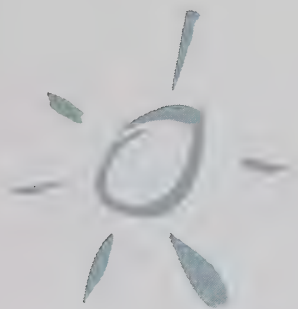
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*The world's first
 fuel-cell-powered
 transit bus completed
 two years of successful
 field operation in
 Vancouver.*

ners include Gas Technology Canada, the Canadian Electrical Association, Ontario Ministry of Environment and Energy, B.C. Hydro and Westinghouse.

- GFI Control Systems Inc. completed 200 000 miles of road testing on vehicles equipped with its novel gaseous-fuel-injection system, which was developed with support from CANMET. The company received Ford Qualified Vehicle Modifier certification, and is establishing the first Ford-certified modifier station.
- WRC provided technical advice to a project involving Imperial Oil Ltd., Syncrude Canada Ltd. and the National Research Council to analyze Canadian diesel fuel composition and emissions. The project relates to another joint WRC-Syncrude project designed to increase the quality of fuels produced from unique Canadian resources. Both projects form part of the Canadian Oil Sands Network for Research and Development.
- CANMET, Gas Technology Canada and Ortech International of Mississauga, Ontario, began a study to investigate the effect of newly developed natural gas engine components and control technologies on vehicle design as well as performance and emissions levels. The project will produce a database for designers and manufacturers.

- With support from CANMET, Cal Corporation of Ottawa and the University of Ottawa launched a project to design and test a thermal management system for ambient-temperature electric vehicle batteries. Without thermal management, these batteries perform poorly in cold temperatures and do not last as long. The project is designed to develop a technology applicable to a range of vehicles and batteries.
- WRC provided technical advice to the B.C. Ministry of Employment and Investment on the technologies available for the production of methyltertiarybutyl ether (MTBE), an oxygenate added to new gasoline reformulations. The province is considering a new MTBE production facility.
- BCRI and CANMET began negotiations for a field trial of a mid-range natural gas engine in cooperation with B.C. Gas, Gas Technology Canada, Cummins and Kenworth. The project will complement BCRI's ongoing field trial of a Caterpillar 3006 natural gas engine installed in a Kenworth truck operated by the City of Surrey, British Columbia. The latter field trial is being supported by CANMET, B.C. Gas, B.C. Science Council and California's South Coast Air Quality Management District.

With support from
CANMET, Cal
Corporation of
Ottawa and the
University of Ottawa
launched a project to
design and test a
thermal management
system for ambient-
temperature electric
vehicle batteries.



Chapter Nine

Alternative Energy — Renewable Energy

Energy Sources

Alternative energy is generally defined as including renewable energy sources, such as biomass, small hydro, solar, wind, geothermal, tidal energy and photovoltaic conversion systems. In addition, the term covers new transportation fuels (such as ethanol from renewable energy sources) and new applications of conventional energy sources (such as the use of propane and natural gas as automotive fuels, and batteries in electric vehicles).

■ ■ ■ ■ ■
*Renewable energy,
mainly biomass,
supplies about
6 per cent of total
primary energy
demand in Canada.*

Renewable energy, mainly biomass, supplies about 6 per cent of total primary energy demand in Canada. The pulp and paper industry uses biomass (wood and pulping wastes) for about half its energy requirements, and the residential sector uses wood to meet 6.5 per cent of its energy demand. There are small hydroelectric installations in some provinces, totalling 1500 MW of capacity across Canada. Other renewable forms of energy, however, remain in limited use: wind (comprising 23 MW of electrical generation capacity); solar (totalling more than 10 000 hot water systems and 170 commercial and industrial systems); and earth energy. It is expected that all these energy sources will be used more in the future, but biomass energy will enjoy the strongest industrial base.

Renewable Energy Market Assessments

Purpose

To assess the potential of renewable energy resources and commercially available technologies for meeting energy and environmental goals.

Activities

The Renewable Energy Market Assessments initiative addresses the potential of various technologies and power sources, including

biomass, tidal and small hydro power, and geothermal, wind and solar power, to contribute to environmental objectives. Activities include:

- compiling data on current demand and use;
- compiling data on supply constraints relative to demand;
- evaluating market prospects for available and new technologies; and
- developing strategies to increase the ability of the renewable energy sector to match products and supply in identified markets.

Achievements in 1994–95

- NRCan funded a market analysis study with the Canadian Institute for Energy Training to review the technical knowledge required by commercial, industrial and institutional customers to understand renewable energy options when selecting and purchasing an energy source.
- The department completed a major study to develop a policy analysis model of forest biomass fuel in Canada. Among renewable sources of energy, biomass fuel has the greatest potential to displace fossil fuels. The computer model of the biomass resource, the conversion of biomass and the marketing of the resulting energy products will help analysts develop appropriate policies to encourage its use.

Information and Awareness

Purpose

To expand the use of renewable energy technologies.

Activities

Awareness of renewable energy will encourage use of the renewable energy technologies and stimulate industry growth. The program examines the information needs of groups such as the public or the renewable energy industry, and prepares information packages showing how renewable energy technology can be applied economically and reliably to meet some energy needs.

To avoid duplication of effort, NRCan negotiates access to materials and markets information packages through environmental groups, trade associations, provinces and other allies. Distribution of information about renewable energy is integrated into the general consumer awareness service that supports all EAE programs.

Achievements in 1994-95

- The department initiated, planned and sponsored the Renewable Energy Commercial Trade Show and Markets Conference, the main renewable energy information event of the year. This event, the first of its kind, provided a forum where decision makers from businesses, energy utilities and other stakeholders could discuss the status of larger renewable energy developments in Canada.
- NRCan continued to meet the high demand for renewable energy publications. The best known is *A Guide to Residential Wood Heating*; 150 000 copies were distributed free of charge to improve the safety of wood-burning in Canadian homes.

Energy from the Forest (ENFOR)

Purpose

To generate knowledge of and technology for forest biomass production in order to encourage the use of forest biomass as an energy source.

Activities

The program, managed by the Canadian Forest Service (CFS), undertakes R&D on

the production of forest biomass for energy through private sector and university contracts and CFS activities at six regional centres and two national institutes. Two primary sources of forest biomass for energy are under study: forest residues, including harvesting residues, and energy plantations, involving short-rotation intensive culture of quick-growing trees such as willows and poplars.

The program seeks to enhance technologies for intensive silviculture to improve biomass productivity, including energy plantations. It also investigates the broad environmental impacts of harvesting and using forest biomass for energy. Economic studies offer regional and national perspectives on short- and long-term advantages and disadvantages, including socio-economic aspects, of different biomass energy sources.

The research involves field experiments and studies, laboratory investigations, data analyses and computer modelling, and socio-economic studies. Results of the research are communicated through scientific papers, technical reports and other publications; workshops and conferences; and demonstrations. By promulgating their results, researchers hope to guide forestry operations toward technology suitable for processing forest biomass for energy, to explain the potential for environmental impacts, and to offer mitigating measures. Key clients include the forest industry, provincial forestry agencies, federal and provincial energy agencies, municipalities, private sector entrepreneurs in energy and forestry, and private landowners.

Achievements in 1994-95

- CFS has developed and promoted the use of a model of carbon inputs and outputs in the Canadian forest sector to investigate the impact of Canadian forests and their use — for bioenergy and other purposes — on national carbon budgets and, eventually, on global climate change. Field studies in 1994-95 over a range of ecosystems provided more reliable data on storage and dynamics of carbon in soil, the most critical

■ ■ ■ ■ ■
The department initiated, planned and sponsored the Renewable Energy Commercial Trade Show and Markets Conference, the main renewable energy information event of the year.

gap in refinement of the model. The model is being widely used to help clarify the role of bioenergy in global climate change.

- CFS supported operational-scale trials of the technology for establishing energy plantations of willow on agricultural land in Ontario and Quebec. Results in 1994–95 showed that using such plantations as biological filters for sewage sludge confers a double benefit — environmental improvement and considerably increased plantation productivity. Quebec municipalities and Hydro-Québec are supporting further work in this area.
- CFS began to receive results from a major series of long-term regional field experiments on changes in soil properties following intensive biomass harvesting. This information will help to define forest management practices that ensure that long-term forest site productivity is not endangered by removal of forest biomass for energy use.
- To facilitate the transfer of research results, CFS produced and widely distributed an annotated, computerized bibliography of all CFS bioenergy reports and publications since the program began in 1979.

Canada–Prince Edward Island Cooperation Agreement on Alternative Energy Development and Energy Efficiency

Purpose

To enhance energy security and energy-use efficiency in Prince Edward Island; to increase production of renewable energy from local resources; to stimulate local employment; to stimulate local entrepreneurial and industrial opportunities in wood-chip harvesting and transportation; and to promote biomass-heating-system fabrication and engineering.

Activities

The Energy Diversity Program provides technical and financial support to the conversion of commercial and institutional heating systems and the installation of new systems to use island biomass fuels. The Energy Efficiency Program, implemented with Prince Edward Island's two electrical utilities, Maritime Electric Co. Ltd. and the Summerside Electrical Utility, uses Prince Edward Island's energy supply more efficiently. The Commercialization Program is federally funded and gives technical and financial support to entrepreneurs to commercialize products and services that show promise in the EAE sector.

Achievements in 1994–95

- NRCan cofunded two small biomass combustion units for application in the agricultural sector.
- The department funded the development of a summary document describing the technical and financial benefits associated with the use of small biomass combustion units in Prince Edward Island.

Renewable Energy Technologies Program

Purpose

To support Canadian industry in developing and commercializing advanced renewable energy technologies.

Activities

The Renewable Energy Technologies Program (RETP) supports Canadian industry's efforts to develop renewable energy technologies, including bioenergy (combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and bio-gas, and biomass preparation and handling), small hydro (less than 20 MW), active solar, photovoltaics and wind energy.

RETP champions and supports technology development and field trials with the renewable energy industry. Two strategic approaches have been adopted: accelerated

CFS supported
operational-scale
trials of the
technology for
establishing energy
plantations of willow
on agricultural land
in Ontario and
Quebec.

penetration of renewable energy technologies into the Canadian market and the exploitation of international opportunities. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry commercialize its products.

Technology development takes several forms, including projects conducted on a cost- or task-shared basis with industry and others. Laboratory services in support of photovoltaics are available at EDRL in Varennes, Quebec, and, in support of biomass use, at ERL in Ottawa. These laboratories have state-of-the-art testing facilities to help clients conduct R&D or technology evaluations. RETP also acts as a catalyst to combine the R&D and funding efforts of other organizations whenever possible, to help industry meet technology development goals more quickly. It also provides technical support for the development of policies and regulations. In addition to private sector companies, program partners include universities, energy utilities, trade associations, other federal and provincial departments, and research institutes.

RETP conducts technology transfer through field trials, workshops, seminars and participation in trade shows to disseminate technology advances within the industry and among potential users. The program also participates in the development of technical standards that help remove trade barriers to Canadian technologies in international markets.

Achievements 1994-95

- CANMET negotiated a \$9.4-million contract with about 80 per cent private sector funding for Iogen Corporation of Ottawa to develop an integrated process for the production of fuel ethanol from cellulosic feedstocks such as wood waste. Other participants are Agriculture and Agri-Food Canada, Environment Canada and Amoco Corporation.

- CANMET provided funding to Laval University to test a prototype 120-kW tubular 'S' turbine at Laval's new Hydro Turbine Test Laboratory. Results are consistent with performance predictions. The turbine design has been licensed to Les Turbines Hydro Énergie Canada Industries Inc. of Québec City for worldwide manufacturing and marketing.

- Arbokem Inc. of Vancouver, in collaboration with B.C. Chemicals, struck a licensing agreement with CANMET for a technology to convert biomass oils into a diesel-fuel cetane-enhancer that can help reduce emissions from diesel engines. B.C. Chemicals has approved the commercial development of this technology by Arbokem. Following testing at ERL, it is expected that B.C. Chemicals, with continued technical assistance from CANMET, will establish a commercial unit capable of processing 20 000 tonnes per year.

- EDRL's photovoltaic energy storage activities are assisting the Canadian photovoltaic industry to develop and use highly reliable, cost-effective, energy-storage systems and to solve design problems. With financial and technical support from EDRL, Soltek Energy of Victoria, British Columbia, developed a new lead-acid battery-bank insulating compartment that will improve battery output in northern climates by up to 10 per cent and extend battery life by 15 to 20 per cent. Optimally sized battery banks will improve system reliability and reduce system costs by up to 20 per cent.

- CANMET provided support to Ensyn Technologies, of Ottawa, Ontario, who launched two projects to increase the commercial application of its rapid thermal processing (RTP) technology. The RTP process converts waste biomass into a renewable liquid fuel for power generation.

■ ■ ■ ■ ■
CANMET negotiated
a contract for Iogen
Corporation of
Ottawa to develop an
integrated process for
the production of fuel
ethanol from
cellulosic feedstocks
such as wood waste.

- The first project, a cost-shared agreement with Hawker Siddeley Canada, demonstrated that the bio-oils produced from RTP can be used in a gas turbine.
- The second project, an agreement led by Wartsila Diesel of Finland with significant involvement from the Technical Research Centre of Finland, demonstrated that diesel engines can also use the bio-oils for power generation.
- CANMET awarded a contract to Tacke Windpower Inc. of London, Ontario, to design, construct and evaluate a 600-kW wind turbine suitable for grid-coupled windfarm applications. The company, a subsidiary of Tacke Windtechnik of Germany, is redesigning the turbine for the North American market.
- A CANMET study of the use of solar energy to heat the vast quantities of water used in finfish aquaculture was completed, demonstrating increased aquaculture productivity and lower costs. Two workshops were held with members of Canada's solar power and aquaculture

communities, resulting in a proposal to undertake commercial-scale pilot trials of the technology with the University of Guelph's Aquaculture Research Centre. Feasibility studies are also under way at three large salmon hatcheries in British Columbia.

- The PV for the North Program, conducted by EDRL in partnership with the Science Institute of the Northwest Territories, is aimed at adapting photovoltaic (PV) systems to the specific conditions of the Arctic. A technico-economic study prepared by EDRL clearly identified potential applications for PV in the North. Over 17 MW of potentially cost-effective PV applications have been identified.
- In cooperation with PAPRICAN and Environment Canada, ERL's Combustion Research Group began to evaluate the effectiveness of various combustion technologies in minimizing air toxins when burning salt-laden biomass fuel as well as wood mill wastes.

■ ■ ■ ■ ■

The PV for the North Program is aimed at adapting photovoltaic systems to the specific conditions of the Arctic.

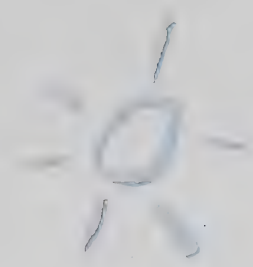


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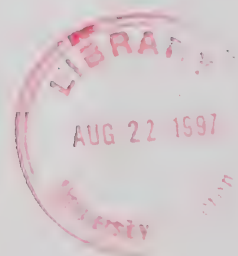
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*Report to Parliament
on the Administration
and Enforcement
of the*

Energy Efficiency Act

1995-96



Canada

His Excellency the Right Honourable Roméo LeBlanc,
P.C., C.C., C.M.M., C.D., Q.C.
Governor General of Canada
and Commander-in-Chief

Your Excellency:

I have the honour to present the *Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act* for the fiscal year ending March 31, 1996, in accordance with section 36 of the act.

■ ■ ■ ■ ■
Respectfully submitted,



A. Anne McLellan
Minister of Natural Resources

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Loi sur l'efficacité énergétique, 1995-1996

Minister's Foreword

1995-96 Report to Parliament



Natural Resources Canada (NRCan) delivers a number of Efficiency and Alternative Energy (EAE) Program initiatives to assist Canada in limiting its greenhouse gas emissions. This report to Parliament presents these initiatives and describes their achievements in 1995-96.

The EAE Program employs five policy instruments to influence energy use in Canada: federal leadership, regulation, voluntary programs, information, and research and development. In 1995-96, the program made major accomplishments in each of these areas:

- In terms of *leadership*, I submitted the federal government's action plan — *Emissions Reductions from Federal Operations* (ERFO) — to the Climate Change Voluntary Challenge and Registry (VCR) in the fall of 1995. With respect to its own operations, the federal government intends to surpass the national goal of stabilizing greenhouse gas emissions at 1990 levels by the year 2000. ERFO describes actions to promote energy efficiency and alternative energy in federal buildings and vehicles. NRCan assists federal departments through three initiatives under the EAE Program: the Federal Buildings Initiative, FleetWise, and the Federal Industrial Boiler Program.
- The Government approved *regulations* setting minimum energy performance standards for certain types of lighting equipment. This action will reduce carbon dioxide emissions by 5.3 megatonnes in the year 2000.
- Under its *voluntary programs*:
 - NRCan established a new Industrial Energy Innovators Initiative to work with companies in establishing and achieving energy-efficiency commitments at the company level.
 - NRCan launched RenoSense, a national sponsorship marketing initiative to encourage Canadians to make their homes more energy-efficient. In March 1996, RenoSense Planning Centres were displayed in over 900 Home Hardware stores.
- As an *information* initiative, NRCan sponsored the development of the first *Canadian Renewable Energy Guide* by the Solar Energy Society of Canada Inc. The guide is a comprehensive directory of renewable energy products, services and companies.
- In terms of *research and development*:
 - With assistance from NRCan, Tacke Windpower Inc. successfully demonstrated a modified 600-kW, German-designed wind turbine to meet Canadian climatic conditions. The company invested in a factory near Huron Park, Ontario, to manufacture wind turbine blades as a result of this project.
 - Results from NRCan's Advanced Houses Program showed that, on average, advanced houses use one-third of the energy needed to supply a conventional house.

NRCan has also been working with the Department of Finance to ensure a level playing field with respect to energy efficiency, renewable energy and non-renewable energy investments. In the February 1996 budget, the Government announced that:

- measures would be developed to extend flow-through share financing, already available to oil, gas, and mining investments, to certain renewable energy investments; and
- the Department of Finance and NRCan would undertake consultations on tax and other options to improve the treatment of energy-efficiency investments and investments providing heating and cooling from renewable energy sources.

As a result of these consultations, the Government announced in the February 1997 budget that it will set aside \$60 million over three years, starting in 1998, to promote investments in energy efficiency in new and existing commercial buildings and renewable energy projects. NRCan and the Department of Finance will develop further details on these initiatives and announce the final design later in 1997.

In addition to these achievements that influence energy use in Canada, NRCan continued to enhance its capability to monitor and report on energy-efficiency trends in Canada. This capability will help the Department assess the progress of its initiatives and identify opportunities for new actions. Under the National Energy Use Database initiative, NRCan:

- doubled the number of establishments covered by the *Industrial Consumers of Energy Survey* to provide the Canadian Industry Program for Energy Conservation with reliable energy-use data to track its progress; and
- collected monthly data on energy use and distance travelled in private vehicles for the first time since 1987, through the *National Private Vehicle Use Survey*.

At the organizational level, NRCan made an important change that brought together energy science and technology (S&T) and energy policy and programs. This will mean better technical support for policy and program responsibilities and clearer policy direction for the advancement of the Government's S&T objectives in the energy sector of the economy.

At the same time, the Department re-oriented the Program of Energy Research and Development to place greater emphasis on energy efficiency, renewable energy, and the mitigation of energy-related greenhouse gas emissions.

Since both federal and provincial governments administer EAE programs, coordination and partnership between them is essential to avoid duplication and ensure efficient program delivery. Since 1993, these imperatives led NRCan and five provincial departments responsible for EAE programs to sign Letters of Cooperation on energy efficiency and alternative energy. This Report highlights their achievements in a new chapter on federal-provincial cooperation.

More efficient energy use and appropriate use of alternative energy sources are vital to sustainable development in Canada. They result in fewer polluting emissions, new jobs and economic growth, without diminishing the level of services Canadians obtain from energy. In this Report, there are many examples of how NRCan and its partners are working together to realize these outcomes.

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Policy Context and Regulations

Overview

As part of its mandate, Natural Resources Canada (NRCan) promotes the sustainable development and use of Canada's energy resources. The economic and environmental benefits of improving the efficiency of energy use and increasing the use of alternative energy sources are significant to fulfilling this responsibility. The federal government's *Energy Efficiency Act*, which gives the Minister of Natural Resources the authority to promote energy efficiency and alternative energy (EAE), also requires the Minister to table before Parliament an annual report on the administration and enforcement of the act.

This fourth *Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act* covers activities during the fiscal year ending March 31, 1996, which promote greater energy efficiency and the use of alternative transportation fuels and renewable energy sources.

Chapter One describes:

- the importance of energy to Canadians;
- the federal approach to EAE; and
- NRCan's strategy to encourage Canadians to invest in greater EAE.

Chapter Two outlines:

- regulatory powers under the act;
- the current energy-efficiency and labelling regulations;
- the program for developing energy performance and labelling regulations;
- compliance provisions;
- communication activities;
- regulatory achievements in 1995-96; and
- work under way to expand regulatory coverage.

Chapter Three outlines federal-provincial letters of cooperation on EAE program delivery.

Chapters Four through Ten describe NRCan's EAE program initiatives, which are managed by:

- the Energy Efficiency Branch;
- the Energy Technology Branch and the Mineral Technology Branch under the Canada Centre for Mineral and Energy Technology (CANMET);
- the Energy Resources Branch; and
- the Science and Sustainable Development Directorate of the Canadian Forest Service.

■ ■ ■ ■ ■
*The Energy Efficiency
Act gives the Minister
of Natural Resources
the authority to
promote energy
efficiency and
alternative energy.*



Chapter One

Introduction

Energy Use in Canada

Canadians are fortunate. We enjoy an abundance of energy and a variety of energy sources. Our high standard of living is attributable, in part, to a reliable supply of energy at a reasonable cost.

This advantage led to the development of industries with a particularly strong demand for energy. It also helped Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. As a result, Canada consumes more energy per capita than most countries.

The importance of energy to Canadians and the Canadian economy is indicated by the proportion of total expenditures devoted to it per year. Canadians spend more than \$70 billion per year on energy to heat and cool their homes and offices, and to operate their appliances, cars and industrial processes. This represents about 10 per cent of our gross domestic product. The economic importance of energy varies from region to region, but wherever it is used, it is fundamental to our way of life. Energy demand will continue to respond to the growth of the Canadian population and economy, moderated by improvements in the efficiency with which we use energy.

Primary energy use is the total requirement for all uses of energy. This includes:

- energy used by consumers;
- energy used to transform energy from one form to another; and
- energy used by suppliers to produce and deliver energy to the market.

Primary energy use in Canada today reflects changes over the past two to three decades in energy-consuming equipment and buildings, and in the behaviour of energy users.

Between 1984 and 1994, primary energy use increased by 24 per cent, from 8 148 petajoules (PJ) to 10 077 PJ (see Figure 1). Over this period, the oil share of primary energy use fell by 4 percentage points, from 40 per cent to 36 per cent. The share held by coal also decreased, from 14 per cent to 11 per cent. Nuclear energy's share increased from 7 per cent to 12 per cent, and natural gas and hydro electricity also increased their share of primary energy use.

Secondary energy use refers to the energy used by final consumers in the residential, agricultural, commercial, industrial and transportation sectors. It accounted for almost 73 per cent of primary energy use in Canada in 1994, and grew from 6 932 PJ in 1990 to 7 314 PJ in 1994. Figure 2 shows each sector's share of total secondary energy use in 1994. The industrial sector has been the most significant energy user of the five, accounting for 39 per cent of total secondary energy use in 1994. The transportation sector has been and continues to be the second-largest energy-using sector (27 per cent), followed by the residential (19 per cent) and commercial (13 per cent) sectors. The agricultural sector accounts for a small share of secondary energy use.

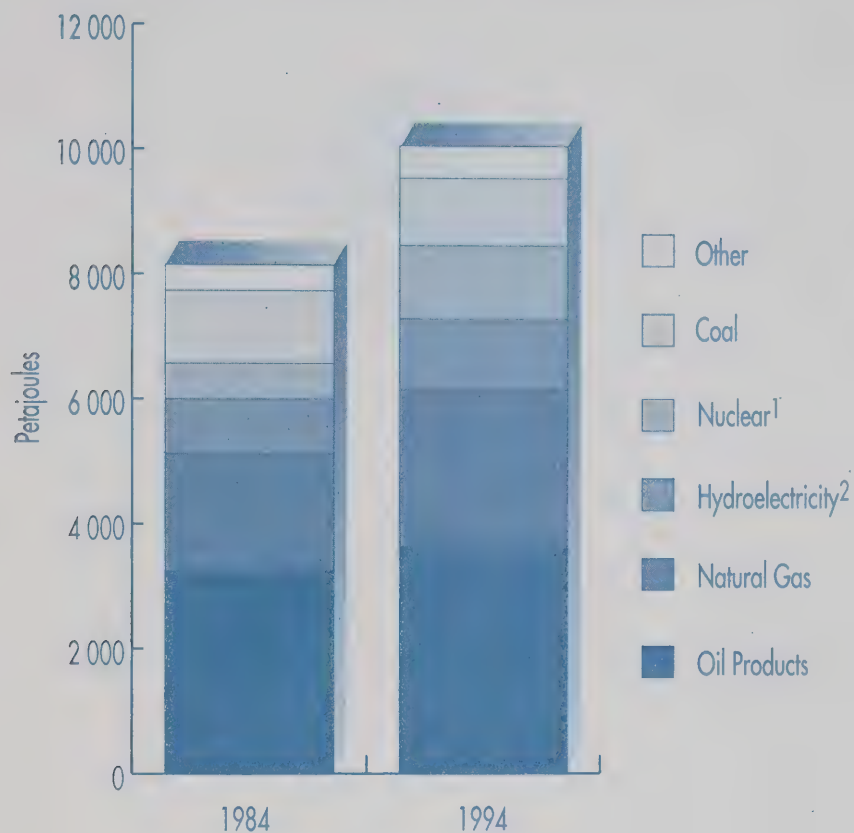
Federal Policy and Programs on EAE

Energy use has been a policy concern since the 1970s. In response to the oil crises of 1973 and 1979, governments took steps to promote energy conservation, primarily to reduce reliance on imported oil. At the time, energy prices were regulated below world levels, making it unlikely that the marketplace would make the necessary energy-efficiency improvements.

■ ■ ■ ■ ■

*Canadians
spend more than
\$70 billion per year
on energy.*

Figure 1. Primary Energy Demand By Fuel, 1984 and 1994



1. Conversion factor: 11.564 k J/Wh

2. Conversion factor: 3.6 k J/Wh

Source: Energy Efficiency Branch, NRCan.

By the mid-1980s, world oil shortages had become world oil gluts. Governments deregulated energy prices and markets, phasing out most energy conservation programs in the belief that the marketplace, left alone, would attain an optimal level of energy-efficiency improvements.

By the end of the 1980s, however, individuals, organizations and governments had become concerned about the atmospheric effects of burning fossil fuels, such as coal, oil and natural gas. In particular, concern was developing around the world that greenhouse gas emissions from the use of fossil fuels could contribute to climate changes.

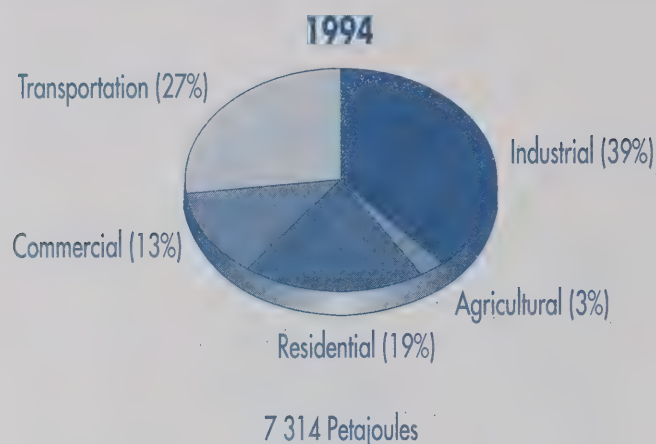
In 1990, Canada's concern about its greenhouse gas emissions, which are largely due to energy use, spurred a major program expansion to address the significant barriers

to increasing energy efficiency and the use of alternative sources of energy. This program expansion took into account:

- the need for flexibility as programs mature and our understanding increases about the implications of global warming and of EAE opportunities;
- international competitiveness and trade commitments; and
- other policy objectives, especially fiscal restraint.

The EAE program supports economically feasible increases in energy efficiency and use of alternative energy sources. It encourages investment in corporate and consumer EAE opportunities, and it seeks to engage all sectors of the economy and Canadian society in rethinking and improving energy

Figure 2. Secondary Energy Use by Sector, 1994



Source: Energy Efficiency Branch, NRCan.

use. The program uses a variety of policy instruments, including information, voluntary actions, R&D and regulation. In all cases, it emphasizes partnership with stakeholders, such as other levels of government, the private sector and non-governmental organizations. In this manner, the program helps the demand side of the energy market move toward more energy-efficient capital stock, production processes and operating practices, without reducing the service or comfort levels they provide. On the supply side of the energy market, the program ensures that Canada participates in the development of technology for tapping renewable energy sources and alternative transportation fuels.

NRCan's EAE program also provides a foundation for longer-term processes that can respond to evolving environmental and economic development priorities. Through the program, the department has enhanced its statutory authority, improved its data-gathering and analysis capabilities, and forged stronger information and planning frameworks with the provinces and other strategic allies.

In 1992, Canada signed and ratified the United Nations Framework Convention on Climate Change. Under this convention, Canada and other countries agreed to work

to stabilize greenhouse gas emissions at 1990 levels by the year 2000. On February 20, 1995, federal and provincial ministers of energy and environment approved the National Action Program on Climate Change (NAPCC). On April 5, 1995, the NAPCC was tabled at the first meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change in Berlin. The NAPCC sets out the strategic directions Canada will follow in pursuit of its objective to stabilize greenhouse gas emissions, and it provides guidance for further actions beyond the year 2000. The NAPCC highlights continuing and enhanced activities, and new and proposed measures. A key element of its strategy is promoting greater energy efficiency in all sectors of the economy.

The approach set out in the NAPCC includes continued support for voluntary action to limit greenhouse gas emissions. Voluntary participation from a broad range of sectors is critical to the success of the NAPCC. To reinforce the impetus toward voluntary action, federal and provincial ministers of energy and environment agreed in February 1995 to establish the Climate Change Voluntary Challenge and Registry (VCR). This federal-provincial initiative is broadening awareness of the need to act and publicizing the plans and accomplishments

■ ■ ■ ■ ■

The NAPCC sets out the strategic directions Canada will follow in pursuit of its objective to stabilize greenhouse gas emissions.

of organizations that succeed in reducing greenhouse gas emissions. The Minister of Natural Resources is the champion of the VCR.

The VCR invites Canadian companies and organizations to commit to develop action plans to limit their net greenhouse gas emissions and to file their commitments, action plans, progress reports and achievements with the VCR. Several of NRCan's EAE program initiatives — especially the Industrial Energy Efficiency Initiative (see chapter seven) and the Energy Innovators Initiative (see chapter five) — greatly assisted a quick and substantive response by industry to the VCR's invitation. Other EAE program initiatives link the VCR with potential participants. The National Energy Use Database initiative (see chapter four) contributes expertise to the development of the data and information elements of the VCR.

Flexibility has been a hallmark of NRCan's EAE program activities. Several initiatives have been restructured as milestones were reached, obstacles encountered, opportunities identified or budgets changed.

Energy-Efficiency Strategy

Many of NRCan's EAE initiatives deal solely with energy efficiency. These initiatives are presented in chapters five through eight, according to end-use sector — buildings, equipment, industry and transportation. The goal of these initiatives is to improve energy efficiency by:

- increasing the energy efficiency of new and existing buildings, equipment, systems and vehicles;
- persuading individuals and organizations to purchase more energy-efficient buildings, equipment, systems and vehicles;
- ensuring that energy-consuming equipment is used in the most energy-efficient way (e.g., keeping furnaces well-tuned and operating vehicles at optimal speeds);
- influencing the daily energy-use practices of individuals and organizations (e.g., to

use public transit instead of personal vehicles); and

- developing technology to provide consumers with new opportunities to improve energy efficiency.

NRCan's key policy tools are:

- *regulation* — setting energy-performance levels and labelling requirements for certain types of equipment, and working with provincial governments to improve the energy-efficiency aspects of Canadian building codes;
- *voluntary initiatives* — working with companies and institutions to establish and achieve energy-efficiency objectives on a voluntary basis;
- *information* — disseminating energy-efficiency information to specific groups of consumers; and
- *R&D* — supporting development and deployment of more energy-efficient equipment, processes and technologies.

Figure 3 shows how these policy tools work together to reduce the amount of energy needed to obtain a certain level of service. Regulation eliminates less energy-efficient goods from the marketplace. Voluntary programs and information seek to persuade consumers to purchase the most energy-efficient goods available and use them correctly. R&D creates new, more energy-efficient technologies for the marketplace.

Alternative Energy Strategy

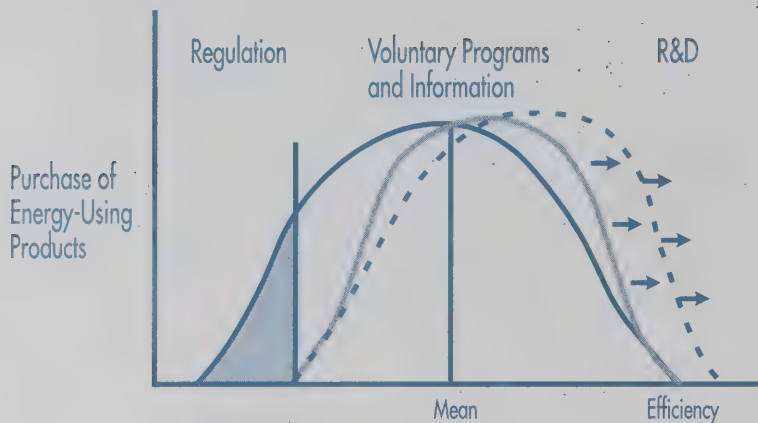
In the short term, energy-efficiency improvements can contribute significantly to energy savings and environmental objectives. In the longer term, however, holding greenhouse gas emissions at 1990 levels will probably require fundamental changes in how we produce and use energy. Among other changes, this may mean relying considerably more on alternative energy sources.

Alternative energy includes renewable sources other than large hydroelectric

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Voluntary programs and information seek to persuade consumers to purchase the most energy-efficient goods available and use them correctly.

Figure 3. Moving the Market



facilities (e.g., bioenergy and solar energy) and new applications of conventional sources (e.g., natural gas used as a transportation fuel). Some technologies, especially for forestry biomass and fuelling vehicles with propane and natural gas, are already commercially available and accepted. Some have found applications in specialized markets, such as remote communities. Other technologies are still in the early stages of development. Chapters nine and ten describe what NRCan is doing to help develop and encourage the use of alternative sources of energy.

NRCan directs its activities concerning alternative transportation fuels toward the most technically promising and most marketable fuels, including propane, natural gas, methanol and ethanol. Federal initiatives are helping to expand the infrastructure (e.g., availability at fuel stations) for these fuels and their markets, especially in urban areas with air-quality problems that can be alleviated by increased use of alternative transportation fuels. R&D is focused on ways to improve the options for these fuels. For the longer term, NRCan is assisting the development of hydrogen and fuel-cell technologies and electric vehicles.

Renewable sources of energy, such as hydraulic, biomass, wind and solar, are generally recognized as important, potential contributors to the reduction of global warming. NRCan allocates most of its support for renewable energy to R&D to

reduce costs, improve performance, develop safety and performance standards, and increase the scope of renewable energy technologies. Other activities involve disseminating reliable information to consumers, and assessing economic and environmental factors.

In November 1995, the federal government outlined a new Renewable Energy Strategy in its *Federal Action Program on Climate Change*. The strategy calls for the Government to act as a catalyst, implementing measures to move renewable energy technologies into the marketplace faster and bringing down barriers that currently hinder or prevent adoption of renewable energy products. To advance performance and reduce costs, the government will continue to support R&D activities. To expand consumer awareness and market acceptance, it will continue to strengthen its activities on information, commercial demonstration and deployment of renewable energy technologies. The strategy is designed to achieve several objectives:

- limit greenhouse gas emissions;
- promote sustainable development;
- enhance energy security and economic prosperity;
- build a diverse and competitive energy mix; and
- foster a strong industry to generate economic and environmental benefits for Canada.

Renewable sources of energy, such as hydraulic, biomass, wind and solar, are generally recognized as important, potential contributors to the reduction of global warming.

Chapter Two

The *Energy Efficiency Act* and Regulations

The Act

The *Energy Efficiency Act* received Royal Assent on June 23, 1992, and came into full force on January 1, 1993. The act gives the federal government the authority to make and enforce regulations concerning EAE, primarily:

- energy-performance levels for energy-using products, doors and windows that are imported into Canada or shipped between provinces;
- energy labelling of energy-using products, doors and windows that are imported into Canada or shipped between provinces; and
- collection of statistics and information on energy use and alternative energy.

Under the act, before a prescribed product is imported into Canada or shipped between provinces, the dealer must submit an energy-efficiency report that describes the product and its energy-efficiency performance. Also, dealers who import prescribed products must provide NRCan with customs-clearance documents regarding the product shipment and the purpose of importation. The Minister of Natural Resources has the authority to designate inspectors to ensure compliance with the provisions of the act and regulations. In addition, the Governor in Council may make regulations regarding:

- testing of energy-using products;
- detention, disposition or destruction of seized goods;
- exemptions; and
- implementation of the provisions of the act.

The Regulations — Energy-Performance Levels for Equipment

Purpose

To eliminate less efficient energy-using equipment from the Canadian market by establishing minimum energy-efficiency performance levels for equipment.

Program Description

Establishing Performance Levels

Regulations under the *Energy Efficiency Act* prohibit imports or interprovincial trade in energy-using products that do not meet a prescribed level of energy efficiency. The products and levels are established after energy and economic analysis, and consultation with stakeholders. The major stakeholders are the provincial and territorial governments, manufacturers of energy-using equipment and their associations, electric utilities, and public interest groups. In choosing products to regulate and efficiency levels to establish, NRCan is guided by considerations of:

- energy savings;
- economic attractiveness;
- impact on Canadian manufacturers; and
- harmonization with other jurisdictions, especially the provinces and the United States.

For specified products, the required performance level and testing procedures are identified in the regulations. NRCan helps develop these standards by funding

Regulations under the
Energy Efficiency Act
prohibit imports or
interprovincial trade
in energy-using
products that do not
meet a prescribed level
of energy efficiency.

and participating in standards-writing committees under the auspices of the Canadian Standards Association and the Canadian Gas Association.

In February 1995, NRCan established energy-performance levels for the following products, which account for about 65 per cent of residential energy demand:

- major residential appliances — electric clothes dryers; clothes washers; integrated over/under washer-dryers; dishwashers; refrigerators, freezers and combination refrigerator-freezers; and electric and gas ranges;
- space-conditioning equipment — room air conditioners, single-package and split-system air conditioners and heat pumps, ground- or water-source and internal water-loop heat pumps, and gas furnaces;
- water-heating equipment — oil-fired, gas-fired and electric; and
- other energy-using equipment — fluorescent lamp ballasts and electric motors.

These regulations complement energy-efficiency regulations in Ontario, British Columbia, Quebec, Nova Scotia and New Brunswick, which are applicable to products sold within their borders. They also parallel regulations in the United States. The performance levels for products covered by the federal regulations are largely harmonized with levels prescribed for the same products by provincial regulations.

NRCan is developing or considering amendments to these energy-performance regulations in six areas:

- adding products that the provinces began regulating after federal regulations took effect in February 1995;
- regulating bulged reflector and elliptical reflector lamps, and revising the classification system for incandescent reflector lamp requirements;
- adding commercial and industrial products that are identified and ranked in an NRCan-commissioned study by the

Centre de recherche industrielle du Québec and are not currently regulated in other jurisdictions;

- adding products that are regulated in the United States but not in any Canadian province;
- adding products that are being considered for regulation by the U.S. Department of Energy; and
- increasing the performance levels for currently regulated products.

Compliance — Monitoring and Enforcing Performance Levels

Much of the program concerns monitoring the industry and enforcing the regulations. These activities are undertaken through agreements with third-party certification agencies accredited by the Standards Council of Canada. To detect non-compliance, NRCan has a monitoring program with provincial utilities and Revenue Canada — Customs and Excise. The two elements of the compliance system are set out in regulations:

- **Verification Mark** — To ensure that products meet energy-performance levels set out in the regulations, the energy performance of the product must be verified by a certification organization. A province may also verify the energy performance of a product if the province's energy-performance requirements meet or exceed federal requirements. The certification agency must be accredited by the Standards Council of Canada. The verification mark must be placed on the exterior of the product before it is sold or leased.
- **Customs Reports** — Customs sends NRCan customs-release documents that must be completed by dealers who import a prescribed product. The reports must include specific information:
 - product name;
 - brand name;

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In February 1995, NRCan established energy-performance levels for products which account for about 65 per cent of residential energy demand.

- model number;
- dealer's name and address; and
- purpose for which the product is being imported.

NRCan's approach to compliance is outlined in *Compliance Policy for the Energy Efficiency Act and the Energy Efficiency Regulations*, released in March 1995.

NRCan is committed to achieving a high level of compliance with the act and the regulations. The department believes that voluntary compliance is most likely when all parties affected by the act and regulations support them. This philosophy is reflected in the following operating principles for administering the act:

- consulting stakeholders;
- minimizing the regulatory burden;
- harmonizing with other jurisdictions;
- cooperating with key players; and
- informing regulatees and the public.

Several key elements of the compliance system are set out below:

- **Monitoring Imports** — The *Energy Efficiency Act* and Regulations require that dealers who handle prescribed products report their energy performance to NRCan. Monitoring at border points has been instituted in collaboration with Revenue Canada — Customs and Excise. Products reported on customs documents are verified against information in NRCan's database to ensure that they comply with performance requirements. Officials follow up on cases of non-compliance or submission of incomplete customs reports.
- **Third-Party Monitoring** — Third-party monitoring is carried out by independent certification organizations such as the Canadian Standards Association, the Canadian Gas Association, Underwriters' Laboratory, Warnock Hersey, and ETL Testing Laboratories Inc.
- **Inspections** — NRCan conducts periodic marketplace audits. For example, seven

qualified inspectors designated by the Minister select products for performance testing in qualified laboratories. NRCan has also approached provincial governments to designate inspectors. Industry Canada has volunteered its inspectors to work on NRCan's behalf. This proposal is under review.

Communications

Since the regulations came into force, NRCan has produced and distributed various documents to inform interested parties of their requirements. Fact sheets have been produced on the following topics:

- reports under section 5 of the *Energy Efficiency Act*;
- how to import an energy-using product into Canada;
- energy-efficiency verification marks;
- exemptions from the *Energy Efficiency Regulations*; and
- EnerGuide labels for energy-using products.

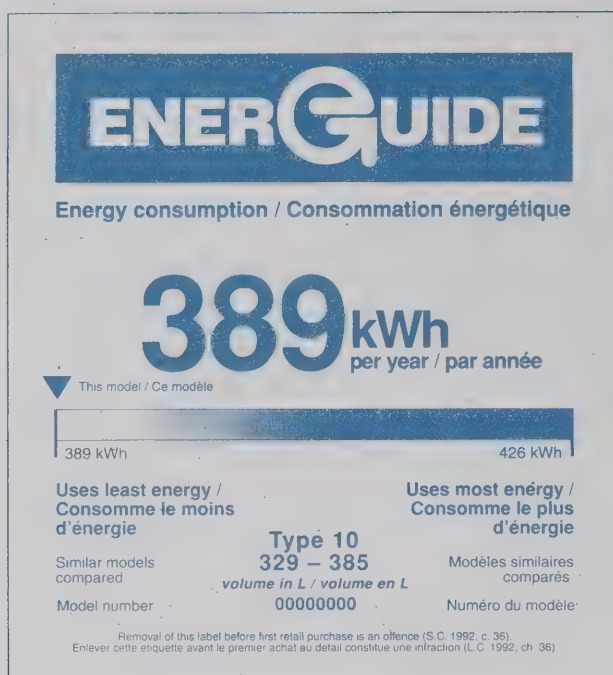
NRCan also distributed a compliance policy document that gives general information on the act and the regulations. Finally, NRCan periodically publishes *The EnerGuide Reporter*, a newsletter about the regulations, development of standards, regulatory requirements, marketing initiatives and related activities.

Achievements in 1995-96

- NRCan amended the regulations to include performance levels for fluorescent lamps (effective February 1, 1996) and incandescent reflector lamps (effective April 1, 1996) that harmonize with levels set out in the 1992 U.S. *Energy Policy Act*. The regulated lamps are used primarily in general area lighting, particularly in the commercial sector. In the *Regulatory Impact Analysis Statement* (RIAS), NRCan estimated that the regulation of these lamps would result in:
 - a saving of almost 10 PJ of energy in the year 2000, increasing to 13.4 PJ in 2020; and

NRCan amended the regulations to include performance levels for fluorescent lamps and incandescent reflector lamps that harmonize with levels set out in the 1992 U.S. Energy Policy Act.

Figure 4. EnerGuide Appliance Label



- a decrease in carbon dioxide (CO₂) emissions by 5.3 megatonnes (Mt) in the year 2000, increasing to 9.8 Mt in 2020.
- NRCan produced and distributed several documents to educate interested parties on the regulations' requirements and on the lamp amendment:
 - *Guide to the Energy Efficiency Regulations;*
 - *Lamp Replacement Guide;* and
 - new fact sheets on electric motors and lighting products.

The Regulations — Energy Labels for Equipment (EnerGuide)

Purpose

To encourage consumers to purchase energy-efficient equipment by disseminating information on the energy performance of a range of competing products.

Program Description

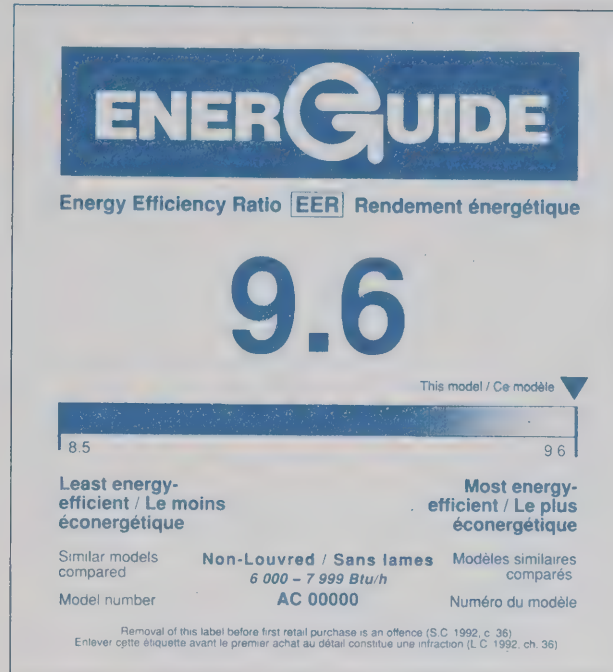
The first regulations under the *Energy Efficiency Act* included labelling requirements for eight major household appliances. They also introduced a new EnerGuide label that shows a product's annual energy use and its ranking on an energy-efficiency scale for similar products available in Canada. The eight products are:

- electric clothes dryers;
- clothes washers;
- dishwashers;
- electric ranges;
- freezers;
- integrated over/under washer-dryers;
- refrigerators and combination refrigerator-freezers; and
- room air conditioners.

EnerGuide labels for major household appliances describe energy performance in annual kilowatt-hours (kWh) (see Figure 4). EnerGuide labels for room air conditioners

The first regulations under the Energy Efficiency Act included labelling requirements for eight major household appliances.

Figure 5. EnerGuide Room Air Conditioner Label



The annual
consumption figure
lets the buyer
calculate the lifetime
operating cost, or
“second price tag,” of
the product model.

describe energy performance as an energy efficiency ratio (see Figure 5). Both labels give consumers consistent and verifiable energy-efficiency information they can use when selecting an appliance.

The EnerGuide appliance label has two significant features. First, it states the annual energy consumption for that product, based on standard energy efficiency tests. The annual consumption figure lets the buyer calculate the lifetime operating cost, or “second price tag,” of the product model. Second, for consumers wishing a visual comparison, the label shows the energy-efficiency range as a bar with a pointer to indicate how that model’s energy consumption compares with the energy consumption of other models of the same product.

Products that must bear the EnerGuide label are selected in consultation with stakeholders. Marketplace monitoring and enforcement systems are implemented through audits on the frequency of labelling. Comprehensive information and education campaigns foster consumer understanding of the EnerGuide label and

the benefits of energy efficiency. These campaigns involve preparing and distributing publications, media releases and exhibits. In collaboration with its strategic allies, NRCan develops training programs to teach retail salespeople how to use the EnerGuide label. Major electric utilities and manufacturers are now considering these training programs.

Achievements in 1995–96

- The 1996 *EnerGuide Directory: Energy Consumption Ratings of Major Household Appliances*, which lists all products labelled by manufacturers, contains about 4 000 entries, 20 per cent more than in 1995. The 1996 *Directory for Room Air Conditioners* contains 25 per cent more entries than in 1995. This increase in products indicates that manufacturers are more accurately making the reports required under section 5 of the *Energy Efficiency Regulations*.
- NRCan issued several guides to help the appliance industry improve its labelling practices. These guides include:

- *Instructions for EnerGuide Labelling;*
- *Labelling Scale for Major Household Appliances;* and
- *General Design Guidelines for the EnerGuide Logo.*
- NRCan and the U.S. Federal Trade Commission (FTC) continue to work on harmonizing their energy label systems. The FTC recently amended its EnergyGuide label under its Energy Labelling Rule to incorporate elements similar to the Canadian label, such as the labelling scale. Both countries will work to harmonize reporting procedures in preparation for allowing "dual labelling" by manufacturers; that is, apply both the Canadian and U.S. labels back to back on the same tag. The appliance industry has asked for this harmonization because most appliances sold in Canada are manufactured in the United States or by U.S. companies with manufacturing facilities abroad.
- The EnerGuide Advisory Committee, with industry participation, began to develop a set of principles to guide the selection of additional products to be labelled.
- An omnibus survey undertaken in March 1996 found that 45 per cent of respondents are aware of the EnerGuide label. EnerGuide also undertook several focus groups to determine what information consumers need when shopping for new appliances. EnerGuide has received several suggestions for improving the presentation of information in its publications and on the retail floor.
- EnerGuide extended its expert training module in New Brunswick in a cost-sharing arrangement with New Brunswick Power. Under this arrangement, staff will visit appliance salespeople across the province to promote EnerGuide and discuss the benefits of energy-efficient appliances. A follow-up survey revealed that the information received in the training sessions is used by appliance salespeople.
- EnerGuide launched a World Wide Web home page for consumers interested in purchasing energy-efficient appliances or using appliances more efficiently. The Internet address is <http://eeb-dec.nrcan.gc.ca>

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An omnibus survey undertaken in March 1996 found that 45 per cent of respondents are aware of the EnerGuide label.

Chapter Three

Federal-Provincial Letters of Cooperation

Letters of Cooperation on EAE

Because both federal and provincial governments administer programs to increase energy efficiency and the use of alternative energy, coordination and partnership between governments is essential to avoid duplication and ensure efficient program delivery. Since 1993, these imperatives have led NRCan and departments responsible for EAE programs in five provinces (Saskatchewan, Nova Scotia, Newfoundland, British Columbia and New Brunswick) to sign Letters of Cooperation on Energy Efficiency and Alternative Energy. The letters of cooperation cover all forms of program initiatives, and establish a management committee of representatives from NRCan and the provincial department to administer the agreement. Typically, the management committee:

- reviews energy and environmental policy and program developments;
- reviews progress on joint program initiatives; and
- discusses possible areas for further cooperation in terms of EAE program delivery.

Each letter of cooperation requires a report to the responsible federal and provincial ministers. The following sections indicate achievements in 1995–96 or provide highlights from reports prepared during 1995–96. In addition to cooperating with provinces and territories through letters of cooperation, NRCan works closely with provincial and territorial departments of energy in other ways:

- NRCan managers and staff work with provincial and territorial counterparts on specific program initiatives; and
- NRCan belongs to the intergovernmental Conservation and Renewable Energy

Subcommittee (CARES) under the Advisory Committee on Energy.

Achievements in 1995–96

Canada-Nova Scotia Letter of Cooperation — Highlights from Report Covering November 1993 to March 1996

- The R-2000 Home Program in Nova Scotia has set records for homes enrolled and builders registered in 1994 and 1995. More than 180 homes were enrolled at the end of December 1995, up from fewer than 70 in 1993. There are currently more than 70 registered R-2000 builders in the province. The program is administered by the Nova Scotia Home Builders' Association (NSHBA) with the sponsorship of NRCan, Nova Scotia Power, the Nova Scotia Department of Natural Resources (NSDNR) and Kerr Controls.
- In 1993, Statistics Canada undertook a *National Survey of Household Energy Use* for NRCan. This survey produced information on the energy characteristics of household equipment and housing, and factors that affect energy consumption. Nova Scotia was one of five provinces that contributed to the survey; the provincial survey results were published in August 1995.
- The Commercial Safety College in Masstown, Nova Scotia, has operated the Maritime component of the Pro-Trucker Program since July 1994. The program is supported by NRCan, NSDNR and the New Brunswick Department of Natural Resources. Between November 1993 and

March 1996, about 125 seminars were delivered to Nova Scotia truck drivers.

- In March 1994, a major Advanced Houses Program workshop attracted 100 participants. The workshop was organized by NSDNR and NSHBA, and delivered by NRCan staff and local participants in Advanced Houses projects.
- NSDNR and NRCan co-produced a video on passive solar energy to inform builders and consumers about solar technologies and products. It was distributed in the province and across Canada.

Canada-Newfoundland Letter of Cooperation — Highlights from Report Covering April 1994 to March 1996

- Since 1994, 52 builders have been trained and two R-2000 homes have been certified, bringing the total number of R-2000 homes in Newfoundland to 158. As part of an evaluation trial of R-2000 homes, the Newfoundland and Labrador Housing Corporation constructed social housing and housing units for seniors and Aboriginal people.
- During the 20 months that the Letter of Cooperation has been in place, the Newfoundland Department of Mines and Energy and NRCan cooperated on the energy-efficiency retrofit of government buildings. This included the development of program instruments, such as an energy performance contract, and the identification of energy service companies.
- Between April 1994 and March 1996, under the Pro-Trucker Program, West Viking College delivered about 100 seminars to truck drivers in the province on vehicle selection, preventive maintenance, fuel-efficient driving techniques and fuel conservation.
- Phase II of the Newfoundland Auto Propane Market Development Project, which started in April 1994, will finish in March 1997. The goal of the project is to expand the number of propane-fuelled vehicles in Newfoundland from about

200 to more than 750 by March 1997, and to develop the infrastructure required to support this number of vehicles. The project is proceeding very well. The supporting infrastructure, developed by Superior Propane, now comprises 34 propane refuelling stations, including a 24-hour cardlock facility in St. John's, and four conversion and service centres in western and central Newfoundland and on the Avalon Peninsula.

Canada-British Columbia Letter of Cooperation — Highlights from Report Covering January 1995 to March 1996

- NRCan and the B.C. Ministry of Employment and Investment (BCMEI) cooperated in defining a provincial program to improve the energy efficiency of public buildings in British Columbia, modelled after NRCan's Federal Buildings Initiative.
- NRCan, BCMEI and BC Hydro funded research projects on the national energy codes for buildings and houses that demonstrated the economic and environmental benefits of adopting the codes in British Columbia. NRCan and BCMEI also cooperated on several other fronts:
 - development of core training materials;
 - development of options for compliance and enforcement; and
 - organization of an Energy Code Forum in Vancouver in February 1996.
- NRCan, BCMEI and other partners worked with the National Research Council on possible home energy retrofit guidelines.
- NRCan, BCMEI and other partners continued to develop a home-energy rating system pilot project in British Columbia.
- The Pro-Trucker Program, supported by NRCan and BCMEI, provided training to fleet drivers about energy-efficient vehicle selection, maintenance and

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*NSDNR and NRCan
 co-produced a video
 on passive solar
 energy to inform
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 consumers about solar
 technologies and
 products.*

driving practices. Training packages were developed for bus, light-duty, municipal and logging fleets.

- NRCan, BCMEI and Centra Gas are co-funding a demonstration of 85 natural gas vehicles on Vancouver Island to promote their benefits in commercial and municipal fleets. By March 31, 1996, 25 vehicles had been converted, and four vehicle refuelling appliances had been installed.
- NRCan and BC Gas are co-funding a demonstration of 300 factory-built natural gas vehicles in the B.C. lower mainland to promote their benefits to commercial and municipal fleets. Twenty-one vehicles were ordered in 1995-96.
- NRCan, BCMEI and other partners began to develop a methanol vehicle demonstration project in the lower mainland to demonstrate the benefits to commercial and municipal fleets.
- NRCan and BCMEI supported and collaborated with the Canadian Industrial Energy End-Use Data and Analysis Centre at Simon Fraser University in

Burnaby. During the 1995-96 period, the Centre focused on establishing a consistent database on Canadian industrial energy end use and communication activities.

- NRCan, BCMEI and other partners completed a study of district energy applications and opportunities in the province. BC Gas undertook to investigate the feasibility of one option: a district energy system for Kamloops.

Canada-New Brunswick Letter of Cooperation on Energy Efficiency and Alternative Energy

- This letter was signed on July 25, 1995, by George Rideout, Parliamentary Secretary, (on behalf of A. Anne McLellan, the Minister of Natural Resources) and Laureen Jarrett, the New Brunswick Minister of Natural Resources. As an example of this cooperation, Mr. Rideout and Ms. Jarrett also announced the launch of an auto-propane demonstration project for New Brunswick.

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*The Pro-Trucker
Program, supported
by NRCan and
BCMEI, provided
training to fleet
drivers about energy-
efficient vehicle
selection, maintenance
and driving practices.*

Efficiency and Alternative Energy Programs

Overview

The remaining chapters of this report describe NRCan's 39 EAE program initiatives. Chapter four outlines three general initiatives. Chapters five to eight detail 27 energy-efficiency initiatives in the four energy-using sectors: buildings, equipment, industry and transportation. Chapters nine and ten set out program initiatives to increase the use of alternative energy: five initiatives on alternative transportation fuels in chapter nine, and four initiatives on renewable energy in chapter ten. For each of the 39 EAE program initiatives, this report sets out their:

- purpose — what they are trying to achieve;
- description — what they do to carry out their purpose; and
- achievements from April 1, 1995, to March 31, 1996.

Table 1 lists each initiative and the 1995-96 expenditures in each area.

Many EAE program initiatives described in this report resulted from science and technology development supported by the Government's interdepartmental Program of Energy Research and Development (PERD). PERD is the only federal R&D program focused specifically on the energy sector to

improve its contribution to the Canadian economy and its effect on the environment. In 1995-96, PERD was reoriented to increase its emphasis on energy efficiency, renewable energy and the energy-related issues of climate change and greenhouse gas emissions.

Other federal departments also have EAE initiatives; for example, other departments conduct EAE research under PERD. Tax relief provisions, such as the absence of a fuel excise tax on natural gas, propane, neat methanol, ethanol and the alcohol portion in ethanol- and methanol-gasoline blends, are another measure. Also, under certain circumstances, Class 43.1 of the *Income Tax Act* provides an accelerated capital-cost allowance for specified energy-efficient and renewable energy technologies. In its March 1996 budget, the federal government announced that it intends to allow the use of flow-through share financing for intangible costs and equipment associated with the development of renewable energy projects that are eligible for Class 43.1 treatment. The Government also announced that it intends to consider specific tax and other options to improve the treatment of investments in energy efficiency and investments to produce heating and cooling from renewable energy sources.

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Many EAE program initiatives described in this report resulted from science and technology development supported by the Government's interdepartmental Program of Energy Research and Development (PERD).

Table 1. EAE Initiatives and Expenditures for 1995-96 (\$ million)

General Programs	6.2
Consumer Information	
Advanced Integrated Energy Systems Technologies	
National Energy Use Database	
Energy Efficiency — Buildings	13.6
Federal Buildings Initiative	
National Energy Codes for Buildings and Houses	
R-2000 Home Program	
Home Energy Retrofit Initiative	
Energy Innovators Initiative	
Federal Industrial Boiler Program	
Buildings Energy Technology Advancement Plan	
• Residential Buildings	
• Large Buildings	
• Passive Solar Program	
Heat Management R&D for Buildings	
Energy Efficiency — Equipment	3.7
Energy Performance Regulations	
EnerGuide Labelling Program	
Window Labelling Program	
Heating, Ventilating and Air Conditioning Energy-Efficiency Rating Program	
Energy Efficiency — Industry	19.4
Industrial Energy Efficiency	
Canadian Energy Management and Environmental Training Program	
Industry Energy R&D Program	
Industrial Targeted Program	
Heat Management R&D for Industry	
Advanced Technologies for Process Optimization and Control	
Minerals and Metals Technologies	
Gas Technologies R&D Program	
Advanced Combustion Technologies Program	
Energy Efficiency — Transportation	3.7
Motor Vehicle Fuel Efficiency Program	
Auto\$mart	
Fleet Energy Programs	
Transportation Efficiency R&D Program	
Alternative Energy — Alternative Transportation Fuels	10.6
Propane	
Natural Gas	
Methanol	
Ethanol	
Alternative Transportation Fuels R&D Program	
Alternative Energy — Renewable Energy	8.8
Renewable Energy Market Assessments Program	
Information and Awareness Program	
Energy from the Forest Program	
Renewable Energy Technologies Program	
TOTAL	66.0

Note: This table presents estimated NRCan expenditures during fiscal year 1995-96 on EAE initiatives by end-use sector or by type of alternative energy. Initiatives that cover several or all sectors are listed under General Programs. This table does not include expenditures on R&D initiatives related to fossil-fuel production.



Chapter Four

General Programs

Consumer Information

Purpose

To increase Canadians' awareness of the environmental effect of energy use and to encourage energy-efficient practices and the use of alternative energy sources.

Program Description

NRCan has a broad range of marketing activities to promote EAE. NRCan produces and markets numerous general readership publications as well as publications that target more specialized users. Topics include:

- home energy efficiency;
- energy-efficient office equipment, heating systems, appliances and lighting products;
- energy-efficient transportation; and
- alternative transportation fuels.

This initiative also produces program documentation and promotional products.

NRCan's extensive national exhibits program features EAE program initiatives such as:

- Auto\$mart;
- FleetWise;
- Energy Code for Houses;
- Energy Efficiency Codes and Regulations;
- Heating, Ventilating and Air Conditioning (HVAC);
- Federal Buildings Initiative;
- Energy Innovators;
- Reno\$ense;
- The Energy-Efficient Office;

- The R-2000 Home; and
- EnerGuide.

The consumer information initiative also provides marketing support to all EAE programs.

Achievements in 1995-96

- NRCan distributed 1.4 million copies of more than 300 EAE publications either directly to individuals or through program allies.
- NRCan arranged for the promotion of its seven public service announcements by television stations across Canada. These public service announcements feature the EnerCat character who reminds Canadians to use energy efficiently. The promotion of these public service announcements resulted in an estimated 33,875,000 viewings by Canadians.
- In collaboration with Canada Mortgage and Housing Corporation (CMHC), NRCan produced *Energy Times*, an energy-efficiency magazine distributed by mail and in newspapers. The magazine included articles on home energy renovations, energy-efficient office equipment, energy-efficient appliances, high-performance windows, R-2000 Homes and vehicle maintenance. *Energy Times* was delivered to almost 1.3 million Canadian households.
- NRCan produced and distributed 70 000 copies of the 1996 *Energy and the Environment* calendar, featuring children's drawings that promote energy efficiency and provide environmental tips.

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*NRCan distributed
1.4 million copies of
more than 300 EAE
publications either
directly to individuals
or through program
allies.*

Advanced Integrated Energy Systems Technologies

Purpose

To develop technology, technology transfer, financing and marketing options for integrated community energy systems.

Program Description

This program helps Canadian communities become more energy efficient by applying technologies that interconnect heat sources and sinks, and by finding efficient, ozone-friendly ways to satisfy the demand for cooling. Technologies include district heating and cooling, combining the production of heat and power, industrial waste-heat recovery, and thermal storage. The program works with Canadian industry, energy utilities, researchers, engineers and other levels of government to develop and transfer technology, and to stimulate interest in community-based energy systems. It also evaluates opportunities to develop and install community energy systems and provides financial and technical support for implementation.

Integrated energy systems receive many forms of support. For example, CANMET organizes seminars to inform energy utilities and municipalities about developments in other countries. It also advises federal and provincial government departments on ways to incorporate energy systems into their planning.

Achievements in 1995-96

- CANMET managed a Windsor Utilities Commission project to evaluate a district energy system that would eventually include gas-fired cogeneration and district heating and cooling. With support from FVB Engineering of Edmonton, Alberta, CANMET conducted a preliminary study of the project. The study focused on the new Windsor Casino

and Courthouse complexes, which were already under construction. The preliminary report has been accepted, and a recommendation has been made to the Windsor Utilities Commissioners to proceed with the next phase of the study.

- In June 1995, CANMET was retained as project manager by the Windsor Utilities Commission to develop a community district energy project. By year-end, contracts had been signed for the construction of a \$25 million project. Initially, this project will reduce CO₂ emissions by more than 4 000 tonnes per year. When the cogeneration plant is completed, this reduction will increase to more than 20 000 tonnes per year.
- CANMET was retained as project manager to evaluate or develop community district energy projects in the following communities: Fort Smith, Northwest Territories; Brantford, Kingston, and Ottawa, Ontario.
- In cooperation with the Federation of Canadian Municipalities (FCM), CANMET arranged a study tour of Swedish community energy system (CES) projects. The participants largely comprised Canadian elected municipal officials. As a result of the tour, the FCM recommended that Canadian municipalities actively consider CES projects.
- CANMET helped to sponsor and organize the first conference of the Canadian District Energy Association, which attracted over 120 municipal and utility representatives. This level of participation demonstrated a growing interest in community energy systems.

■ ■ ■ ■ ■
*Integrated energy
systems receive many
forms of support.*

National Energy Use Database

Purpose

To give decision-makers the information on secondary energy consumption in Canada that they need to assess progress in improving energy efficiency and to analyse opportunities for further improvement.

Program Description

The National Energy Use Database (NEUD) establishes processes for the regular collection and analysis of data on:

- national energy consumption at the end-use level;
- characteristics of buildings and energy-using equipment;
- Canadians' energy-use behaviour and attitudes; and
- adoption of energy-efficient technologies.

NEUD reviews data sources in each end-use sector, assesses data needs, and expands or creates data surveys as required.

NEUD facilitates the establishment, in Canadian universities, of data and analysis centres on specific energy-consuming sectors. These centres compile, organize and analyse energy end-use data and recommend new data sources to NRCan. In 1995, NRCan funded the following centres:

- the Automobile Mobility Data Compendium, at Université Laval in Ste-Foy, Quebec, in association with the Groupe de recherche interdisciplinaire mobilité, environnement et sécurité, examines the use of private vehicles to improve understanding of their impact on personal mobility, energy consumption and environmental quality.
- the Canadian Industrial Energy End-Use Data and Analysis Centre, at Simon Fraser University in Burnaby, British Columbia, in association with the university's School of Resource and Environmental Management, examines industrial energy-use patterns.

- the Canadian Commercial Energy End-Use Data and Analysis Centre, at McMaster University in Hamilton, Ontario, in association with McMaster's Institute for Energy Studies, examines energy use in the commercial sector.
- the Canadian Agricultural Energy End-Use Data and Analysis Centre, at the University of Saskatchewan in Saskatoon, examines energy use in the agricultural sector.
- the Canadian Residential Energy End-Use Data and Analysis Centre, at the Technical University of Nova Scotia in Halifax, examines residential sector energy use, including energy-using equipment and buildings.

Achievements in 1995-96

- NRCan published the 1993 *Survey of Household Energy Use: Provincial Results*, a statistical report discussing the characteristics of household equipment and housing stock based on data collected for NRCan in a March 1993 Statistics Canada survey.
- NRCan sponsored an expansion of Statistics Canada's 1995 *Repair and Renovation Survey* to collect data on energy-retrofit activity in Canadian homes.
- NRCan sponsored an expansion of Market Facts of Canada Limited's 1995 *Household Equipment Survey* to collect detailed information on household equipment acquired by Canadians in 1994.
- NRCan sponsored a survey to collect information on the energy-use characteristics of homes built in 1994.
- NRCan continued to sponsor the *National Private Vehicle Use Survey* to collect monthly data on private-vehicle fuel consumption, kilometres driven, and vehicle and household characteristics.
- NRCan sponsored an expansion, from about 1 000 respondents to about 2 000 respondents, of Statistics Canada's *Industrial Consumers of Energy Survey* for

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NRCan sponsored a
survey to collect
information on the
energy-use
characteristics of
homes built in 1994.

1995. The survey collects data on energy use by fuel for the Canadian Industry Program for Energy Conservation (CIPEC), which interested parties use to monitor progress in energy efficiency. The survey was expanded so it could report reliably on energy use by each of the sectors represented by the 14 CIPEC task forces.

- NRCan updated the Canadian database on EAE programs and made it publicly available for the first time. Using this database, NRCan produced the 1995 edition of the *Directory of Efficiency and Alternative Energy Programs in Canada*, which presents summary data on the EAE programs of the federal, provincial and territorial governments and Canadian gas utilities.
- The Canadian Energy End-Use Data and Analysis Centres delivered several important products:

- the first issues of *enerInfo*, a newsletter about developing, managing and analysing data on energy end-uses in the major energy-consuming sectors;
- feasibility studies on conducting energy end-use surveys of the commercial and agricultural sectors; and
- energy-intensity indicators for major energy-consuming industries (developed for CIPEC by the Canadian Industrial Energy End-Use Data and Analysis Centre).
- NRCan prepared a first report of a two-phase project to examine the methodological and informational requirements of an analysis of energy-efficiency trends in the four end-use sectors of the Canadian economy. The second phase, currently in progress, will produce the first edition of the annual *Energy Efficiency Trends in Canada*, to be available in early 1996-97.

Chapter Five

Energy Efficiency —

Buildings

Energy Use

A building is a system comprising a building envelope, mechanical equipment and occupants. The building envelope is made up of all the materials and surfaces in the building shell, including walls, ceilings, roof, basement walls, windows and doors. Mechanical equipment is the energy-using component of the system. It includes all equipment and appliances related to space heating and cooling, ventilation, lighting, water heating, cooking and humidifying. The interaction of the building envelope, mechanical equipment and energy practices of the occupants determines the overall energy use of the building. This chapter focuses on these aspects of energy efficiency.

In 1994, energy use in residential and commercial buildings amounted to approximately 2 328 PJ, equal to

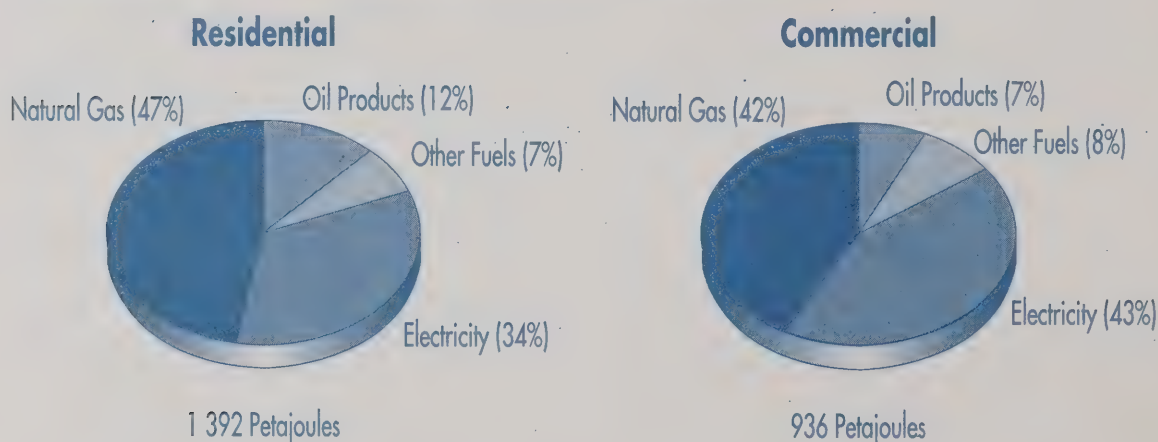
32 per cent of total secondary energy use. Residential buildings accounted for approximately 1 392 PJ (19 per cent of secondary energy use), and commercial buildings accounted for approximately 936 PJ (13 per cent of secondary energy use).

Figure 6 illustrates the fuel mix in each sector. Natural gas is the dominant fuel in the residential sector, accounting for 47 per cent of energy use. In the commercial sector, electricity has increased its share of total energy use so much that it has surpassed natural gas; electricity now accounts for about 43 per cent of sector energy requirements.

In the residential sector, electricity accounts for the second-largest share (34 per cent), and oil accounts for the third-largest share (12 per cent) of energy use.

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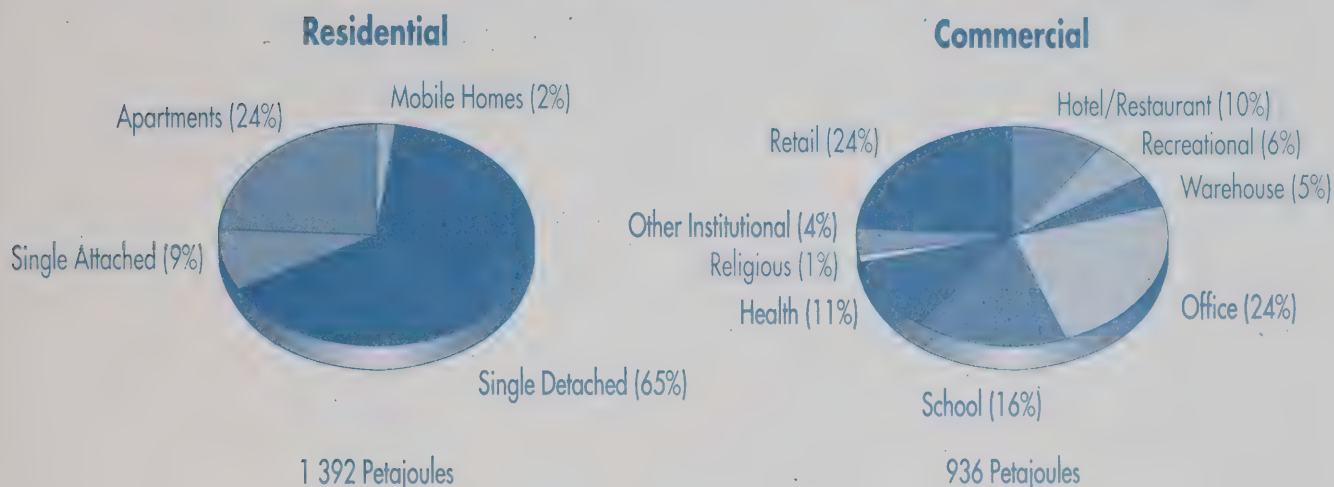
Figure 6. Residential and Commercial Energy Use by Fuel, 1994



For definitions, refer to Appendix C of report; NRCan, *Energy Efficiency Trends in Canada*, Ottawa, Ontario, April 1996.

Sources: Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, Cat. no. 57-003, 1994-IV.
NRCan, Residential End-Use Model.
NRCan, Commercial End-Use Model.

Figure 7. Residential and Commercial Energy Use by Building Type, 1994



For definitions, refer to Appendix C of report, NRCan, *Energy Efficiency Trends in Canada*, Ottawa, Ontario, April 1996.

Sources: Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, Cat. no. 57-003, 1994-IV.
NRCan, Residential End-Use Model.
NRCan, Commercial End-Use Model.

Residential sector
energy intensity,
defined as energy
use per household,
decreased by
2 per cent from
1990 to 1994.

In the commercial sector, natural gas now accounts for the second-largest share of energy use (42 per cent). Oil accounts for almost 7 per cent of commercial energy use. In both cases, other fuel use is almost entirely biomass (wood) and liquid petroleum gases.

Canadian residential and commercial building energy use is compared for different building types in Figure 7. In the residential sector, single detached houses are the major energy-using group. In the commercial sector, energy use occurs in diverse market segments and building types, with office buildings and retail accounting for 48 per cent of energy use.

Developments in Energy Efficiency

Between 1990 and 1994, residential energy use increased by 6 per cent. However, residential sector energy intensity, defined as energy use per household, decreased by 2 per cent from 1990 to 1994. An important

factor affecting energy use in the residential sector is the introduction of new, more energy-efficient housing. As shown in Table 2, the thermal efficiencies of new housing, as measured in terms of resistance values (R-Values), have increased.

Housing units built since the late 1970s tend to be better insulated and more airtight than older units. This trend was observed in the results of the 1993 *Survey of Household Energy Use* (SHEU), which found that houses built after 1978 leak less air than older houses. When asked whether they felt there were any air leaks or drafts from around their windows, 73 per cent of SHEU respondents who owned houses built during or after 1978 answered "no"; however, only 59 per cent of respondents who owned pre-1978 houses felt there were no air leaks from windows. Similar responses were made to questions about air leakage associated with doors. Sixty per cent of SHEU respondents who owned newer houses felt there was no air leakage from around doors, compared with fifty per cent of owners of houses built before 1978.

Table 2. Thermal Envelope Characteristics of New Housing by Period of Construction

Period	Envelope Characteristics	Insulation R-Values		
		Ceiling	Wall	Basement
Pre-1945	Wood-frame construction, ceiling insulation only	10	0	0
1945-1960	2 x 4 wood construction, ceiling and wall insulation	12	10	0
1961-1977	2 x 4 construction, insulation required by building codes	20	12	5
1978-1983	2 x 6 construction, more insulation, air and vapour barriers	30	20	10
1984-1994	More stringent building codes	33	20	12

Source: Peat Marwick Stevenson and Kellogg, *The Economically Attractive Potential for Energy Efficiency Gains in Canada*, May 1991.

SHEU data show a trend toward larger houses. For example, the average heated living space of houses built after 1982 is 1 535 square feet, compared with 1 374 square feet for units built between 1978 and 1982, and 1 287 square feet for units built between 1961 and 1977. Although increases in heated living space contribute directly to increases in energy use, energy-efficiency improvements have more than offset these increases.

From 1990 to 1994, commercial energy use increased by 8 per cent. However, 1994 commercial sector energy intensity, defined as energy use per square metre of floor area, was equivalent to the 1990 level.

In the commercial sector, the efficiency of new buildings today is a result of not only improvements over the last 20 years but also of recent revisions to the energy-efficiency component of provincial and municipal building codes. The most convincing example of these recent revisions is in British Columbia — the Vancouver building code now requires that new construction comply with energy-efficiency levels prescribed by the ASHRAE 90.1 standards. This makes the energy-efficiency requirements of Vancouver's building

code more demanding than those of other jurisdictions.

Occupants' behaviour also exerts a significant effect on energy intensity and energy use. Over the past decade, increased training and information about rational use of energy in buildings and increased penetration of computerized energy-monitoring systems have contributed to the decline in building energy intensity. Recent U.S. surveys of the commercial sector reveal that energy-management control systems for heating and cooling equipment were installed in almost 9 per cent of commercial buildings surveyed in 1992, compared with 3 per cent of buildings in 1983.¹

Federal Buildings Initiative

Purpose

To encourage comprehensive energy-efficiency upgrades and retrofits in federal government facilities.

Program Description

The Federal Buildings Initiative (FBI) provides a full range of products and services for federal departments and agencies

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Although increases in heated living space contribute directly to increases in energy use, energy-efficiency improvements have more than offset these increases.

¹ Energy Information Administration, *Commercial Buildings Characteristics 1992 and Characteristics of Commercial Buildings 1983*, Washington, D.C.

seeking to improve energy efficiency in approximately 53 000 facilities. The program is designed to overcome obstacles, such as lack of money, expertise and staff, that have prevented departments from taking full advantage of energy-efficiency improvements.

Through savings financing, a key FBI strategy, government organizations can make energy-efficiency improvements with no capital outlay. Private sector energy-management companies secure financing and recoup their investment from the resulting energy savings.

The FBI provides access to a wide range of support services that include training, health and safety guidelines, model documents, and plans. Seminars and workshops are held in all regions of the country so that federal facility managers can learn about implementing energy-efficiency projects. Government organizations profit from the strategic alliances developed by FBI with energy-management companies, utility companies and manufacturers of energy-efficient products. FBI provides a mechanism for departments and agencies to respond to the Greening of Government Operations initiative, which asks federal organizations to integrate environmental considerations into their facility operations.

Achievements in 1995-96

- All federal custodian departments are involved in FBI projects, and Crown corporations and federal agencies are using the FBI model to improve the energy efficiency of their facilities. Five provincial governments and several municipalities have also adopted the FBI model to implement energy-efficiency projects.
- All federal custodian departments have agreed to develop energy-management plans for their facilities and to report progress annually to NRCan. These initiatives are summarized in Appendix 1: *Ministerial Reports on Actions Under the Federal Buildings Initiative*.
- As of March 1996, 35 FBI contracts in federal facilities had resulted in private

sector investment commitments of \$120 million involving 2 400 person-years of employment. In total, however, more than 100 projects are at various stages of implementation. When completed, these projects will reduce federal annual energy costs by \$35 million.

- Measures implemented as a result of FBI energy-efficiency projects have made the workplace more comfortable and more productive for employees.

National Energy Codes for Buildings and Houses

Purpose

To increase the energy efficiency of new Canadian buildings by specifying minimum thermal-performance levels and supporting the incorporation of these energy codes into provincial and municipal building regulations.

Program Description

Drafts of the *National Energy Code for Buildings* and the *National Energy Code for Houses* were published in 1996 by the Canadian Commission on Building and Fire Codes through the Canadian Codes Centre at the National Research Council. These model codes outline economically justified levels of energy efficiency for 34 regions in Canada based on regional construction costs, energy prices and climate. The codes have built-in flexibility: different approaches can be used to ensure that a building will comply with the energy code.

The codes were developed by a standing committee under the Canadian Commission on Building and Fire Codes. The research was funded by NRCan, utility members of the Canadian Electricity Association, the provincial and territorial ministries of energy, and the National Research Council.

Achievements in 1995-96

- NRCan raised awareness of the energy codes among builders, designers and

Through savings financing, a key FBI strategy, government organizations can make energy-efficiency improvements with no capital outlay.

others in the construction industry by distributing information materials through travelling exhibits, presentations at conferences, association seminars, trade shows and articles in newsletters.

- NRCan developed the following support tools:
 - user-friendly software for designers and building officials to support optional compliance approaches;
 - a video describing the features of the *National Energy Code for Houses*; and
 - training needs assessments for stakeholders.
- In partnership with the B.C. Ministry of Employment and Investment, NRCan held a one-day Energy Code Forum in Vancouver in February 1996 that attracted more than 300 participants. The next day's annual Energy Code Coordination Committee meeting, which was co-sponsored by NRCan and BC Hydro, drew 65 industry, government and utility representatives from British Columbia and across the country to discuss interprovincial and building-product coordination issues.

R-2000 Home Program

Purpose

To increase the energy efficiency of new houses.

Program Description

The R-2000 Home Program sets a voluntary standard for energy efficiency that exceeds current building codes and for the use of environmentally responsible materials and practices in new housing. Research by NRCan and others ensures that the R-2000 standard evolves and maintains its position at the leading edge of housing technology that is commercially available in the marketplace.

The R-2000 Home Program trains house builders to meet the R-2000 standard, and it tests houses and certifies that they are

built to meet this standard. Through promotion, it encourages buyers to purchase houses that meet the R-2000 standard. NRCan manages the program nationally, but it is delivered at the provincial level through partnerships typically comprising energy utilities, the provincial government, the provincial home-builder association and financial institutions. Private sponsors of the program, such as product manufacturers and equipment suppliers, help market R-2000 in return for the goodwill and publicity associated with the R-2000 name.

Achievements in 1995-96

- More than 30 Canadian private and public sector organizations supported the program in 1995-96, contributing more than \$800 000 to its operations.
- Despite a severe downturn in housing starts across Canada, 586 R-2000 homes were built during 1995-96. In Atlantic Canada, R-2000 maintained its share of housing starts, with more than 10.6 per cent of the market in New Brunswick and more than 4 per cent in Nova Scotia. Almost 7 300 R-2000 homes have been built since the program started in the early 1980s.
- In 1995-96, the R-2000 Home Program trained more than 695 house builders.
- NRCan upgraded the R-2000 standard as of April 1, 1994, the first major technical change since the program began. The new standard increases the energy efficiency of R-2000 houses by about 15 per cent and, for the first time, includes several environmental and health features. During 1995-96, the new standard was implemented across the country.

Home Energy Retrofit Initiative

Purpose

To encourage Canadians to make their homes more energy efficient, especially when undertaking home renovation and maintenance projects.

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*Despite a severe
 downturn in housing
 starts across Canada,
 586 R-2000 homes
 were built during
 1995-96.*

Program Description

The energy performance of most of Canada's 7 million homes could be improved significantly, especially that of the 4.5 million homes built before 1977. The owners of many older homes could save up to 25 per cent of their heating costs if they made certain affordable upgrades.

Each year, more than 50 per cent of homeowners say they are planning to renovate. The Home Energy Retrofit Initiative tries to ensure that these home improvements include energy retrofits. NRCan attempts to link the resources and activities of stakeholders and potential partners — such as provincial governments, energy utilities, trade associations, product and equipment manufacturers, and retailers — to ensure that they give energy-efficiency retrofits a high priority. To this end, NRCan produces *Retro-Vision*, a quarterly newsletter, to inform stakeholders about developments in home-energy retrofit. In collaboration with CMHC and other partners, NRCan also conducts consumer information campaigns to encourage homeowners to upgrade the energy efficiency of their homes while doing general renovations.

Achievements in 1995-96

- NRCan launched RenoSense, a highly leveraged, national sponsorship marketing initiative. The department's first major partner is the Home Hardware Group, with more than 900 retail locations nationwide. In the fall of 1995, a 16-page booklet was distributed through Home Hardware's 266 Home Building Centres across Canada. In March 1996, RenoSense Planning Centres were displayed in all Home Hardware stores. Brochures and videos from NRCan, CMHC and participating product manufacturers show consumers how to integrate energy-efficient features into home renovation projects.
- To satisfy the growing interest in assessing home energy efficiency, NRCan developed and distributed, for comment, draft guidelines for a Canadian Voluntary

Home Energy Rating System. Voluntary guidelines offer consistency in evaluation criteria and could provide financial institutions with the information they need to develop preferential mortgage rates for energy-efficient houses ("green mortgages").

- In cooperation with CMHC and the Canadian Home Builders' Association (CHBA), NRCan launched the Renovation Demonstration 1996 competition to show consumers how to renovate older houses to bring them up to modern energy-efficiency and environmental standards. Six winning proposals from home builders' associations across Canada were announced at the annual CHBA Conference in February 1996. Work on the demonstrations will begin in April 1996.

Energy Innovators Initiative

Purpose

To encourage corporations, institutions and municipalities to increase the energy efficiency of their facilities.

Program Description

The Energy Innovators Initiative (EII) recruits Canadian organizations to register a voluntary commitment to energy efficiency and become Energy Innovators. EII encourages them to implement long-term energy-management plans and helps them begin comprehensive building-retrofit programs.

EII provides Energy Innovators with models for energy-efficient design; access to training, guidebooks and ally networks; and other products and services. EII helps spread energy-efficient technologies and practices throughout large organizations and market sectors. Through agreements established with national associations, such as the recent Memorandum of Understanding signed with the Retail Council of Canada, entire market sectors are encouraged to reduce energy waste and demonstrate their support for protecting the environment

NRCan developed
and distributed, for
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Canadian Voluntary
Home Energy Rating
System.

from greenhouse gas emissions related to energy use.

Achievement in 1995-96

- During 1995-96, EII recruited 104 corporations, institutions and municipalities to register as Energy Innovators, bringing the total of Energy Innovators to 308 across Canada. Collectively, the Energy Innovators control an estimated 80 million square metres of floor space, about 17 per cent of Canadian commercial floor space.

Federal Industrial Boiler Program

Purpose

To assist in the development and implementation of clean, energy-efficient combustion technologies for federally owned boilers.

Program Description

The federal government owns 52 central heating plants that house more than 270 boilers, which consume more than 8 000 terajoules of fuel and produce more than 650 tonnes of nitrogen oxide (NO_x) emissions and 400 000 tonnes of CO_2 annually. The Federal Industrial Boiler Program (FIBP) provides government departments and agencies with services to increase energy efficiency, reduce NO_x emissions, and extend the useful life of boiler systems and auxiliary equipment. The program ensures that energy-efficient and environmentally responsible technologies are considered when government organizations replace or modify their heating plants. The application of proven technologies can reduce NO_x emissions by 50 per cent, increase energy efficiency by up to 15 per cent and reduce operating costs by 20 per cent.

Along with developing site-specific strategies to help boiler operators meet higher equipment-performance targets, FIBP provides turnkey project-management services on new or retrofit combustion technologies, including preparing technical specifica-

tions, reviewing tenders, and overseeing the installation and commissioning of new equipment. Other services include cogeneration feasibility studies, retrofit studies, non-destructive examinations of heating-plant equipment, life-cycle costing studies, on-site test burns, and technical workshops and seminars. FIBP operates on a fee-for-service basis.

Achievements in 1995-96

- FIBP completed its low- NO_x boiler installation at Correctional Service Canada's Saskatchewan Penitentiary. FIBP was contracted to provide turnkey project management for the first low- NO_x installation in Saskatchewan.
- FIBP completed a report entitled *Low- NO_x Technology Assessment for the Combustion of Heavy Oil*, based on a project CANMET conducted with joint funding from Environment Canada and the Department of National Defence. The report examines the use of heavy oil to fuel mid-sized boilers and the emission-reduction challenges it presents. The report includes state-of-the-art technical evaluation, a review of the current regulatory environment in the northeastern United States (which, like Atlantic Canada, depends on this fuel) and several recommendations for emission guidelines for NO_x control in Canada. This report is designed for easy use by regulators, facility managers, and owners and operators of industrial boilers.
- Since 1991, the program has resulted in annual reductions of 15 000 tonnes of CO_2 , 16 tonnes of NO_x and savings of 270 terajoules of energy.

Buildings Energy Technology Advancement (BETA) Plan — Residential Buildings

Purpose

To develop and commercialize energy-efficient technologies for residential buildings and encourage industry to adopt them.

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Since 1991, the Federal Industrial Boiler Program has resulted in annual reductions of 15 000 tonnes of CO_2 , 16 tonnes of NO_x and savings of 270 terajoules of energy.

Program Description

Advanced technologies could reduce energy consumption in residential buildings by up to 50 per cent. Strategic elements of the BETA Plan for residential buildings include technology development, technology transfer and quality assurance for the advancement of energy-efficient and environmentally responsible housing technologies. Priority is assigned to emerging technologies that can be deployed in new buildings or retrofit projects, including residential space- and water-heating systems, lighting, cooling, and ventilation equipment. Activities are cost-shared with key stakeholders in the building industry, resulting in substantial leveraging of federal funds by private sector companies, energy utilities, trade associations, universities and provincial governments. Projects include R&D and field trials of emerging technologies, development of design tools, and technology transfer initiatives.

The BETA Plan encompasses two activities that focus directly on residential buildings. The Advanced Houses Program features the construction, public demonstration and performance monitoring of 10 houses across Canada that use 75 per cent less energy than conventional homes. Building systems and indoor environment activities support the development of advanced building-design tools and systems for heating, ventilation and space conditioning. The BETA Plan also provides industry and other government programs with technical support and advice to accelerate the adoption and application of energy-efficient technologies in buildings. Activities include:

- monitoring building performance;
- collecting energy-use and environmental impact data for conventional and innovative buildings; and
- giving technical advice for other residential building initiatives, such as the R-2000 Home Program and energy utility demand-side management programs.

Achievements in 1995-96

- CANMET established a new benchmark in energy-efficiency building performance with its Advanced Houses Program. Preliminary results show that, on average, Advanced Houses use half the energy of an R-2000 house of similar size and dimension, and approximately 33 per cent of the energy needed to supply a conventional house. Several detailed reports on the performance of these Advanced Houses have been printed, and others will be printed as they become available.
- CANMET completed a market assessment of the innovative technologies demonstrated in Advanced Houses. The assessment indicated that accelerated adoption of the most promising Advanced House technologies could reduce national energy consumption in the low-rise housing sector by 15 to 19 per cent by 2020. High-performance windows offer the greatest potential energy savings for new and existing houses. Advanced gas-fired mechanical systems represent the second most significant energy-saving opportunity. Exterior air barriers, efficient motor and fan sets, and advanced oil heating also offer substantial savings.
- CANMET delivered 12 technology workshops across Canada and the United States on the technical features of the Advanced Houses. A follow-up survey indicated that more than 85 per cent of participants changed their building methods as a result of the workshop.
- In response to industry requests for information on interior finishing materials that ensure better indoor air quality, CANMET co-sponsored six workshops across Canada. In addition to information from the Advanced Houses, CANMET presented a method for predicting indoor air quality based on published data on products such as paints, cabinets and floor coverings.
- CANMET completed research that produced changes in ventilation requirements for R-2000 houses with lower

indoor pollutant emissions. This is the first time a housing program has linked energy-performance requirements with indoor air quality.

- CANMET produced a prototype version of its AUDIT2000 energy-analysis software for home audit and home energy ratings. The version is being tested by more than 40 organizations and individuals involved in renovations, energy utilities, construction and science. Two of the testing organizations, TransAlta Utilities in Alberta and the BC21 PowerSmart Project in British Columbia, have started using AUDIT2000 for full-scale auditing projects. In British Columbia, about 2 200 homes have been audited to date.
- CANMET produced a HOT2000 Developer's Kit to license third parties to create and sell software products that use the HOT2000 energy-analysis calculation core. The first such licensing agreement has been negotiated with Sheltair Scientific Ltd. of Vancouver.
- CANMET continued its work with a number of export ready housing companies to create a new image for Canadian housing exported to Japan. CANMET is beginning to develop Super E™ houses, which are economical, energy-efficient, environmentally friendly and at least 50 per cent Canadian in content. Super E™ houses adapt Canadian housing products for the Japanese market, meeting Japanese codes and standards.

Buildings Energy Technology Advancement (BETA) Plan — Large Buildings

Purpose

To support the building industry's efforts to develop, commercialize and adopt energy-efficient and environmentally responsible technologies for large buildings.

Program Description

Innovative energy-efficient technologies and practices could reduce energy consumption in commercial and multi-unit residential buildings by up to 60 per cent. To meet this long-term goal, the BETA Plan includes a wide range of technology development, technology transfer and quality assurance initiatives to help the commercial and high-rise residential buildings sector improve its energy and environmental performance. Activities address the technology and information gaps that inhibit the adoption of energy-efficient technologies. They include the C-2000 Advanced Buildings Program, and building systems and indoor environment activities. Projects are conducted in close cooperation and on a cost-shared basis with the buildings industry, other federal organizations, provincial governments and energy utilities.

The C-2000 Program is accelerating the adoption of emerging technologies by demonstrating that commercial and highrise residential buildings can be more energy-efficient, have better indoor environments and have reduced environmental impact. C-2000's environmental criteria include curbing CO₂ emissions and using technologies that do not use chlorofluorocarbons (CFCs). Across Canada, several advanced energy-efficient commercial buildings have been designed and funded jointly by a wide range of energy and buildings industry stakeholders, and three are being constructed. Building systems and indoor environment activities focus on developing energy-simulation tools for industry and on analysing and assessing innovative space-conditioning techniques, ventilation equipment, lighting, office equipment and building assemblies. In addition, the program provides technical support for applying advanced technologies in other federal, provincial or utility-led programs that affect large buildings.

Achievements in 1995-96

- CANMET and CMHC jointly sponsor the IDEAS challenge, a national competition

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The C-2000 Program is accelerating the adoption of emerging technologies by demonstrating that commercial and highrise residential buildings can be more energy-efficient, have better indoor environments and have reduced environmental impact.

to improve the design and construction of high-rise apartment buildings. It is committed to moving high-rise standards forward in six areas: energy efficiency, durability, environmental protection, accessibility, health and comfort, and affordability. In 1996, the first high-rise building supported by the IDEAS challenge was completed and officially opened in Montréal, Quebec.

- In Kitchener, Ontario, the first building was completed under CANMET's C-2000 Program. One of the most energy-efficient and environmentally responsible buildings ever constructed in Canada, the C-2000 building will consume about 42 per cent of the energy and 28 per cent of the water that a conventional building designed to current best practices would consume.
- BC Hydro and BC Gas, two major utilities, have launched a new design facilitation program based on CANMET's C-2000 design facilitation process. Design facilitation involves intervention in the design process by skilled facilitators who:
 - take responsibility for promoting teamwork;
 - demonstrate the whole-building performance approach; and
 - bring to the design team new skills such as energy simulation, daylighting and monitoring techniques.

The C-2000 projects in the region indicate that BC Hydro and BC Gas can expect to reduce the cost of their demand-side management programs by making smaller capital contributions earlier in the design stage.

- To develop a new generation of user-friendly simulation software for large buildings, CANMET led the formation of the Canadian Consortium for Building Energy Compliance Software, in partnership with U.S. organizations. The consortium is working to produce, distribute and support software that will monitor compliance with the *National Energy Code* for

Buildings. CANMET is the interim project manager.

- NRCan completed one of the two Green Floors being renovated at its Ottawa headquarters building. The Green Floors project was created to demonstrate NRCan's leadership in energy-efficient and environmentally friendly building practices. The project examined all materials and technologies used to furnish, light, heat, cool and ventilate the floors, as well as demolition and construction practices. Standard practices were improved wherever the environmental impact could be decreased (e.g., recyclable carpets), energy could be saved (e.g., lighting) or the indoor environment improved (e.g., better ventilation). The Green Floors will be monitored for two years.
- CANMET participated in the project definition of the five-year cooperation agreement between the Canadian International Development Agency and the Ministry of Construction of the People's Republic of China to develop energy-efficiency policies, programs and projects across China.

Buildings Energy Technology Advancement (BETA) Plan — Passive Solar Program

Purpose

To develop, commercialize and encourage the adoption of passive solar technologies for residential and commercial buildings.

Program Description

The BETA Plan's Passive Solar Program helps Canadian innovators develop and deploy technologies that increase the use of passive solar energy in buildings. Activities include:

- R&D of high-performance and advanced windows;
- support for market penetration by energy-efficient windows;

- commercial building applications such as daylighting and system integration; and
- passive solar modelling.

Projects range from technology and product standards development and technology assessment to technology transfer and quality assurance.

Activities are cost-shared with industry, mostly small and medium-sized enterprises, and with organizations, including universities, trade associations, research councils, energy utilities and departments and agencies at all levels of government. Program participants match federal funds provided by the Panel on Energy Research and Development.

A major thrust of the program is to promote the deployment of technology through the development of a window labelling program and product and installation standards. For example, the Canadian Standards Association (CSA) developed the A440.2 energy-performance standard to provide a simple rating for residential windows. The A440.2 standard will help the industry more effectively supply high-performance window products for the residential retrofit market. The *National Energy Code for Houses* adopted the simple rating system to specify requirements based on product costs, energy sources and other local conditions.

The program also supports the development of super-high-performance windows that enhance the energy performance of the market's best designs and of ultra-advanced windows based on emerging technologies such as electrochromics or aerogels. Development of computer-simulation and design software and window durability test methods are other key activities.

Achievements in 1995-96

- CANMET hosted Window Innovations '95, an international conference on state-of-the-art window technologies for energy efficiency in buildings. More than 300 participants from 20 countries

represented manufacturing, construction, universities, governments and utilities. This conference allowed Canada to demonstrate leadership in products, design tools and energy-rating systems for northern climates.

- In partnership with Enermodal Engineering Ltd. of Waterloo, Ontario, CANMET developed the FRAMEplus Toolkit, a new software program for evaluating the thermal performance of windows. Unique in North America, the FRAMEplus Toolkit allows window and door manufacturers to rate their products and design more efficient models. Licensing agreements for using the FRAMEplus Toolkit have been signed with Sweden, Italy, Australia and the United Kingdom, and negotiations are under way with Norway and France.

- Based on research funded by NRCan, the CSA finalized and approved a thermal performance standard for doors, CSA A453, in time for adoption by the *National Energy Code for Houses* and the *National Energy Code for Buildings*. It is similar to CSA A440.2, the standard for windows. CSA A453 now forms the basis of a door certification program being developed by the Canadian Window and Door Manufacturers' Association to complement its program for windows.

- CANMET, the National Research Council, Ontario Hydro and the Insulating Glass Manufacturers Association of Canada developed a method for determining the gas concentration of argon-filled insulated glazing units. Fogging and durability tests were also conducted, and the results led to recommendations that address the quality concerns with high-performance glazing. The results will be taken to the Canadian General Standards Board for eventual inclusion in future standards.

- CANMET and Air-Ins, a window testing laboratory in Varennes, Quebec, co-funded a study to investigate window performance in cold temperatures and under wind pressure. This work produced information that was referred to in

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revising standards and improving the lifetime performance of windows.

- CANMET and Enermodal Engineering organized three-day window workshops in four major cities across Canada. The workshops included a full day of training on modelling building envelope components, and a day of discussion on the new *National Energy Code for Houses* and its impact on building designers, energy consultants and code officials.
- A collaborative project between CANMET and Habitechnica of Toronto, Ontario, has produced a passive solar house design manual now in use at universities and colleges with CANMET's HOT2000 energy-analysis software.

CANMET works to
develop and
disseminate advanced
heat-management
technologies and
knowledge on
buildings.

Heat Management R&D for Buildings

Purpose

To help Canadian companies develop, commercialize, acquire or use leading-edge heat-management technologies and techniques for buildings.

Program Description

CANMET works to develop and disseminate advanced heat-management technologies and knowledge on buildings. In addition to improving energy use and environmental performance, these technologies can enhance the economic competitiveness of Canadian industry.

The main delivery mechanism is collaborative, in-house R&D involving manufacturers, service providers and end users in project definition, selection, delivery and financing.

CANMET acts as a catalyst in Canadian heat-management R&D for buildings. Because of CANMET, technologies are developed and applied in Canada more quickly than would happen otherwise.

The Heat Management Program for buildings develops and disseminates advanced heat-pumping, heat-transfer and heat storage technologies and knowledge, including:

- absorption, chemical and hybrid heat-pumping to improve energy efficiency of buildings;
- heat transfer and storage technologies to recover waste heat and decrease peak-loading in buildings;
- process integration tools to improve the energy efficiency of thermal and chemical processes and provide engineering and consulting firms with sophisticated tools to compete in the international marketplace; and
- expert systems and modelling tools to improve energy optimization.

Achievements in 1995-96

- CANMET began to develop a computer-based technology for the optimization, diagnosis and fault detection of heating, ventilating and air conditioning systems in buildings. Such a technology could reduce a building's energy cost by 30 per cent, increase occupant comfort and reduce equipment failure and maintenance cost. This project is carried out in collaboration with the International Energy Agency and involves 10 countries. Technologies developed through these international collaborations will be shared with Canadian manufacturers.
- CANMET began a project to develop software for building energy-management systems. This technology would help building control companies deliver high-performance systems, assist policy-makers in establishing standards, and select systems that will help in the training of operators. This two-year project is being funded by CANMET, Public Works and Government Services Canada, and building control companies.
- CANMET completed the third year of a five-year project to develop a gas-fired absorption heat pump for small commercial buildings. The absorption heat pump is a CFC-free system that complies with the requirements of the Montréal protocol. This \$2.5-million project is funded by a consortium of gas utilities and CANMET.

Chapter Six

Energy Efficiency — Equipment

Equipment Energy Use

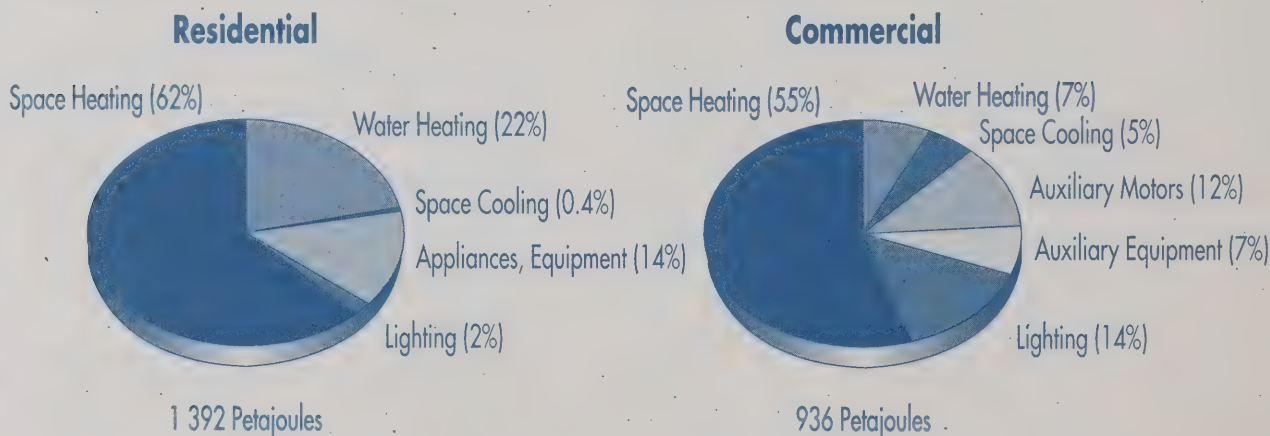
The energy efficiency of a building can be improved through building design and construction techniques (for example, by increasing insulation and airtightness); equipment, such as furnaces and air conditioners; and the equipment-operation and maintenance habits of its occupants. This chapter focuses on energy-using equipment.

Energy-using equipment includes:

- household appliances, including refrigerators, freezers, dishwashers, ranges, clothes washers and clothes dryers;
- water heaters;
- lighting fixtures, including lamps and ballasts;
- space-heating and -cooling equipment, including furnaces, boilers, electric heaters and air conditioners;
- commercial refrigeration units, such as those used in supermarkets; and
- motors, such as those used for ventilation, pumping, elevators and other functions requiring motive power.

Figure 8 provides a breakdown, by equipment category, of residential and commercial energy use. Space heating accounts for the largest share of energy use in both sectors — about 62 per cent in the residential sector and about 55 per cent in the commercial sector.

Figure 8. Residential and Commercial Energy Use by End Use, 1994



For definitions, refer to Appendix C of report, NRCan, *Energy Efficiency Trends in Canada*, Ottawa, Ontario, April 1996.

Sources: Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, Cat. no. 57-003, 1994-IV.
NRCan, Residential End Use Model.
NRCan, Commercial End Use Model.

In the residential sector, water heating accounts for the second-largest share (22 per cent) of energy use, followed by appliances (14 per cent). Space cooling and lighting account for only a small portion of residential energy use.

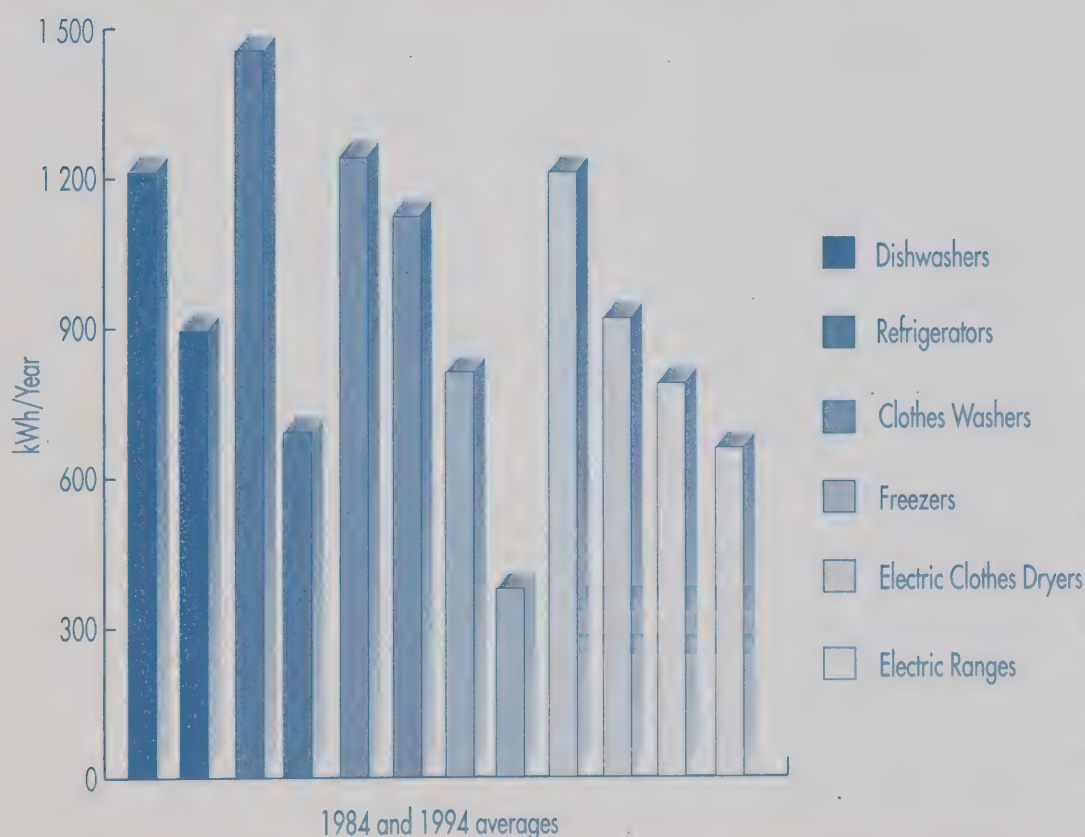
In the commercial sector, lighting is the second-largest end use (14 per cent), followed closely by auxiliary motor power, for example, for pumps, ventilators and other appliances (12 per cent). Electric plug load, water heating and space cooling account for almost 19 per cent of commercial sector energy use.

Developments in Energy Efficiency

In the residential sector, significant energy-efficiency gains have been achieved for the six major appliances over the last decade. Figure 9 illustrates the change in efficiencies for new major appliances between 1984 and 1994. By 1994, for example, the average new refrigerator and freezer were 53 per cent more efficient than their 1984 counterparts. Other energy-efficiency improvements were achieved for dishwashers (26 per cent), electric clothes dryers (24 per cent), electric ranges (15 per cent) and clothes washers (9 per cent).

In the residential sector, significant energy-efficiency gains have been achieved for the six major appliances over the last decade.

Figure 9. Trends in Appliance Energy Use in Canada, 1984 and 1994



Notes: Based on typical appliances in terms of features. Energy consumption for dishwashers and clothes washers includes the energy required to heat the water.

Source: NRCan, EnerGuide Program.

Table 3. Energy-Efficiency Trends for Refrigerators

	New Refrigerator 1984	New Refrigerator 1994
Type	Two-door with top-mounted freezer	Two-door with top-mounted freezer
Features	Automatic defrost	Automatic defrost
Capacity	15.4 cubic feet	17.9 cubic feet
Unit energy consumption	1 457 kWh/year	690 kWh/year

Technology improvements between 1984 and 1994:

- more efficient compressors;
- better insulation; and
- better fans and motors.

Table 3 compares the average unit energy consumption (UEC) of typical new refrigerators in 1984 and 1994. While the UEC of typical new refrigerators decreased by 53 per cent, the size of refrigerators, a factor contributing to energy consumption, increased by 16 per cent. Therefore, the efficiency gains associated with technology improvements more than offset the energy consumption increases associated with size.

Significant energy-efficiency gains have also been realized in natural gas space-heating. In 1984, most of the natural gas furnaces sold were conventional, with annual fuel utilization efficiencies around 65 per cent. By 1990, approximately 37 per cent of the natural gas furnaces sold were mid- and high-efficiency units, ranging in efficiency from 78 to 96 per cent. In 1994, only mid- and high-efficiency units were sold in Canada.

In the commercial sector, energy intensity has continued to improve since 1990. For example, in applications related to new buildings, the trend is toward more energy-efficient lighting, especially T-8 systems. T-8 systems, which only became commercially available in Canada in the late 1980s, are estimated to account for 75 to 95 per cent of sales related to retrofitting existing buildings and installing in new buildings.

Decreases in commercial sector energy intensity because of energy-efficiency improvements during 1984 to 1994 have been slightly offset by greater energy use

caused by market penetration of electronic equipment, such as computers, facsimile machines and printers. Microcomputer sales increased by almost 500 per cent between 1985 and 1994, and more than one million units are now sold annually. Sales of facsimile machines increased ten-fold between 1986 and 1994, and annual laser printer sales rose from very few in the mid-1980s to more than 250 000 in 1995.

Energy Performance Regulations and EnerGuide Labelling Program

Descriptions and achievements of these two programs are provided in Chapter Two.

Window Labelling Program

Purpose

To encourage consumers to buy energy-efficient windows by informing them about the product's energy performance.

Program Description

In the late 1980s, NRCan supported R&D of testing and simulation methods for window products. At the same time, NRCan encouraged the Canadian Standards Association to develop a standard to measure the thermal performance of windows.

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The result was an energy rating (ER) procedure for windows (and, subsequently, for doors) that quantified energy performance. This number lets consumers compare products and helps building inspectors confirm that a product complies with provincial regulations. The ER of a window rates its overall energy performance based on three factors:

- solar heat gain;
- heat loss through the frame, spacers and glass; and
- heat loss from air leakage.

With the support of NRCan and other partners, the Canadian Window and Door Manufacturers' Association (CWDMA) initiated a voluntary certification and labelling program for windows and patio doors using the ER system. The ER system works like the EnerGuide system for household appliances and room air conditioners; it indicates the relative energy efficiency of products to encourage comparison shopping and energy-efficient purchases.

The voluntary certification program is administered by the association, which engages independent auditors to verify that participating manufacturers comply with the CSA window standard, the Canadian General Standards Board standard for sliding doors and the CSA energy-performance rating procedure.

Achievements in 1995-96

- The first CWDMA window labels appeared in early 1995. Since the program was launched, eight manufacturers have joined, accounting for 30 product lines and 128 product options that have been certified and labelled using the CSA energy-performance rating procedure. This progress was achieved despite the worst market conditions ever faced by the Canadian window and door industry.
- With financial support from NRCan, 10 presentations and seminars for potential participants and users of the program were held, and about 700 copies of the *Certified Product List* were distributed.

Approximately 60 000 certified windows and patio doors were made available to the market in 1995-96.

Heating, Ventilating and Air Conditioning Energy-Efficiency Rating Program

Purpose

To encourage consumers to buy energy-efficient furnaces and central air conditioners by informing them about the energy performance of these products.

Program Description

The Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI) recently signed an agreement with NRCan to launch a voluntary program to encourage consumers to buy energy-efficient furnaces, central air conditioners and air-to-air heat pumps. Under this initiative, manufacturers of heating, ventilating and air conditioning (HVAC) equipment sold in Canada place an EnerGuide rating in each HVAC product brochure, showing the range of efficiencies available for the product and the efficiency of the specific model.

Under the agreement, NRCan helps the industry promote the EnerGuide rating by providing a recognition program for manufacturers, and training material and other products and services for dealers.

HRAI has agreed to promote the program to HVAC contractors, ensure the participation of manufacturers, and collect and submit sales data to NRCan to facilitate program evaluation and the setting of sales targets.

Manufacturers will complete enrolment agreements regarding the submission of sales data and the graphic requirements of the EnerGuide rating. Manufacturers are responsible for using the correct model information and rating scale in their brochures, leading the promotional and educational campaign for product dealers, and participating in target-setting and program evaluation.

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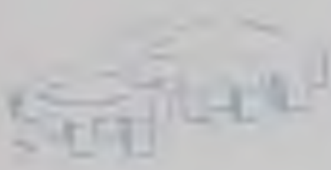
The Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI) recently signed an agreement with NRCan to launch a voluntary program to encourage consumers to buy energy-efficient furnaces, central air conditioners and air-to-air heat pumps.

Product dealers will participate in HRAI and NRCan promotional and educational programs and will use annual energy-use factors in presenting energy-efficiency information to customers.

Achievements in 1995-96

- Ninety per cent of manufacturers selling HVAC equipment in Canada, collectively known as Team HVAC/L'équipe CVC, have enrolled in the voluntary program.
- In March 1996, at the Canadian Environmental Exposition and Mechanexpo, the major industry trade show, several manufacturers displayed promotional literature that included the rating.
- NRCan and HRAI completed pilot training courses for contractors and utility staff. These featured an Annual Fuel Utilization Efficiency slide calculator for gas furnaces and a Seasonal Energy-Efficient Ratio Nomograph for air conditioners.

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Chapter Seven

Energy Efficiency — Industry

Industrial Energy Use

The Canadian industrial sector comprises manufacturing, mining and forestry activities. This sector uses energy for the process-specific technologies of each industry, such as pulp refiners, cement kilns or blast furnaces, and for operating auxiliary devices. Such applications include steam generation and pumping or compression.

Other industrial energy uses are lighting, heating, ventilation and air conditioning.

Table 4 shows that, in 1994, industrial energy use amounted to 2 841 PJ, or 39 per cent of Canada's total secondary energy use. The table also shows that the pulp and paper industry is the predominant energy user, accounting for almost 30 per cent of industrial energy use.

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Table 4. Industrial Energy Use by Sector, 1994

Industry	Petajoules	Per cent
Pulp and Paper	831	29.2
Mining	396	13.9
Petroleum Refining	310	10.9
Chemicals	260	9.2
Iron and Steel	235	8.3
Smelting and Refining	215	7.6
Cement	49	1.7
Construction	35	1.2
Forestry	11	0.4
Other Manufacturing	498	17.6
Total	2 841	100.0

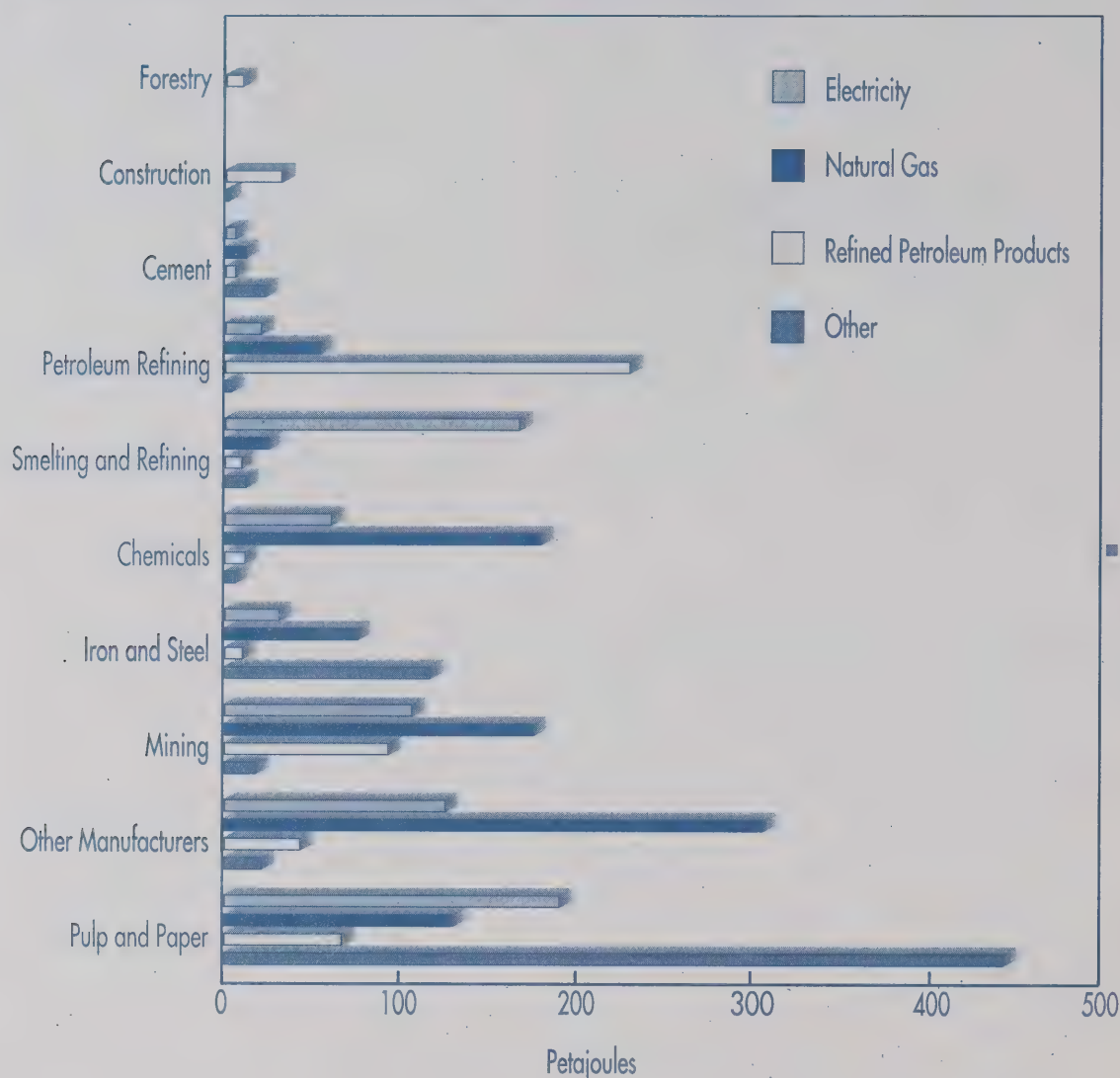
For definitions, refer to Appendix C of report, NRCan, *Energy Efficiency Trends in Canada*, Ottawa, Ontario, April 1996.

Source: Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, Cat. no. 57-003, 1994-IV.

Figure 10 shows secondary energy use by fuel type in the industries that consume the most energy. The three major energy sources used by these industries are natural gas, electricity and refined petroleum products. The pulp and paper industry also consumes large amounts of hog fuel and spent pulping liquor, and the iron and steel industry is a significant consumer of coking coal and coke-oven gas.

Table 5 compares energy purchases with total production costs, showing wide industry variation. However, the cost of energy is only one of industry's considerations — and often not the most important one. Although these data do not reflect the full cost of energy to industrial users in specific sectors, they show that energy purchases do not account for a large share of production costs in many industries.

Figure 10. Industrial Secondary Energy Use by Fuel Type, 1994



For definitions, refer to Appendix C of report, NRCan, *Energy Efficiency Trends in Canada*, Ottawa, Ontario, April 1996.

Sources: Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, Cat. no 57-003, 1994-IV.

Table 5. The Importance of Energy Purchases in Selected Industries, 1993

	Total Production Cost (per cent)	Value of Shipments (per cent)
Cement	33.60	17.72
Chemicals	15.69	10.64
Smelting and Refining	14.37	10.85
Pulp and Paper	11.51	9.23
Iron and Steel	9.55	7.71
Petroleum Refining	2.16	1.92
Other Manufacturing	3.00	1.49

Source: Statistics Canada, *Manufacturing Industries of Canada: National and Provincial Areas*, 1992. Cat. No. 31-203.

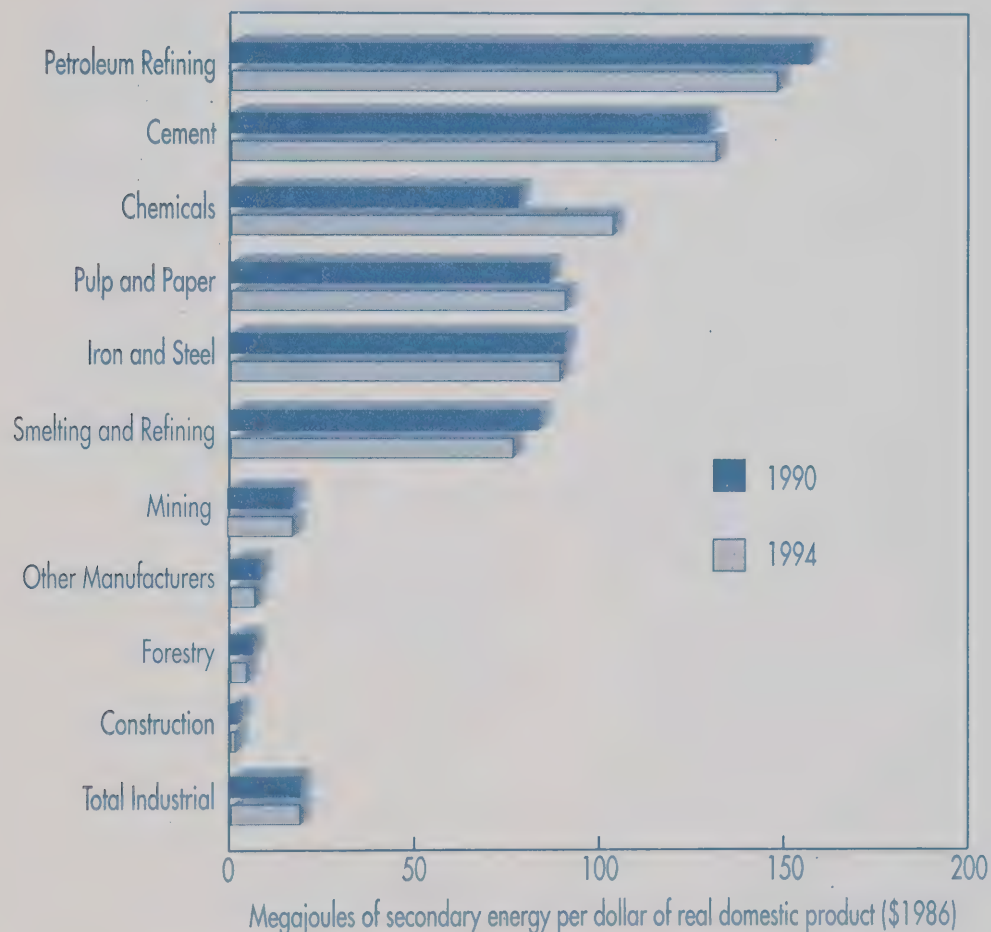
Developments in Energy Efficiency

Over the period 1984 to 1994, industrial energy intensity decreased. Since 1990, continuing efforts by industrial energy users to reduce consumption have helped limit growth in energy use.

Industrial energy demand increased by 4.7 per cent between 1990 and 1994. During the same period, industrial activity, measured by gross domestic product

(\$1986), grew by 3.4 per cent. Figure 11 reflects the result — a 1 per cent increase in industrial energy intensity. This increase had more to do with the change in the distribution of industrial activity rather than the change in energy efficiency. From 1990 to 1994, the share of industrial activity accounted for by the more energy-intensive industries (petroleum refining, cement, chemicals, pulp and paper, iron and steel, smelting and refining, and mining) increased by 1.8 percentage points, while

Figure 11. Industrial Energy Intensity by Sector, 1990 and 1994



For definitions, refer to Appendix C of report, NRCan, *Energy Efficiency Trends in Canada*, Ottawa, Ontario, April 1996.

Sources: NRCan, *Canada's Energy Outlook 1992-2020: Update 1994*, October 1994.
Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, Cat. no 57-003, 1994-IV.

the share accounted for by the less energy-intensive industries (other manufacturing, forestry and construction) declined. When this change is separated from energy intensity, sector-specific energy intensities declined by 1 per cent from 1990 to 1994.

This decline in energy intensity was mitigated by a trend in the pulp and paper industry (which accounts for 30 per cent of industrial energy use) away from fossil fuels and toward wood waste and pulping liquor. Since wood waste has less energy content than fossil fuels, more wood waste and pulping liquor are needed to meet the same end-use requirement. The share of wood waste and pulping liquor increased 3 percentage points to 52 per cent of energy use in the pulp and paper industry in 1994.

Over the 1990-94 period, sector-specific energy intensities declined in the face of decreasing capacity-use rates. Declines in capacity use tend to increase energy intensity, since energy use usually can not be decreased as much or as quickly as production. This is because a certain level of energy requirement is constant.

One industry that made significant energy-efficiency improvements during the 1990-94 period was smelting and refining, the fastest-growing subsector since 1990. The two most energy-efficient aluminum smelters currently in use began operating after 1990.

Industry strives continually to improve its competitive position, and energy efficiency is one way to achieve this objective. To this end, CIPEC promotes energy efficiency in the manufacturing and mining sectors, and measures the progress of each participating industrial sector.

Industrial Energy Efficiency

Purpose

To increase energy efficiency in the manufacturing and mining sectors.

Program Description

The Industrial Energy Efficiency Initiative (IEEI) is based on voluntary action by industry to increase economic competitiveness and limit air emissions through increased energy efficiency. IEEI has the following elements:

- The Minister's Advisory Council on Industrial Energy Efficiency (MACIEE) is a forum where senior industrial executives and the Minister of Natural Resources can discuss energy-efficiency policy, programs and strategies to champion energy efficiency at the industrial sector and company level. The MACIEE meets at least once a year to review the progress of and opportunities for Canadian industry to become more energy efficient. It encourages industry executives to support and implement voluntary energy-efficiency improvements in their sectors and organizations.
- CIPEC coordinates the development of energy-efficiency goals, action plans and services for each industrial sector through a voluntary task force network. The CIPEC task forces work with NRCan, Statistics Canada, and the Canadian Industrial Energy End-Use Data and Analysis Centre to:
 - develop targets and action plans; and
 - monitor and report on progress in meeting energy-efficiency goals in their specific sectors.
- The Industrial Energy Innovators Initiative (IEI) recruits and encourages industrial companies to develop long-term energy-management commitment, planning and replication strategies.

Achievements in 1995-96

- NRCan, the CIPEC sector task forces, Statistics Canada and Environment Canada completed the development of a statistically valid system to monitor and report on the industry's progress toward its targets, based on Statistics Canada's energy and production surveys. Almost

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One industry that made significant energy-efficiency improvements during the 1990-94 period was smelting and refining, the fastest-growing subsector since 1990.

2 000 establishments now provide annual energy and production information to Statistics Canada. The CIPEC task forces use this information to report energy-efficiency improvements on a unit-of-production basis — a world first. These improvements are published in the CIPEC Annual Report.

- The number of active CIPEC sectoral task force working groups increased by five and now total fourteen. Each working group develops energy-efficiency improvement targets and plans for its sector. The energy-efficiency targets vary between 0.7 and 3 per cent of energy improvement use per year, depending on the sector. At year-end, 11 task forces were finalizing energy-efficiency action plans. Overall, the sectors participating in CIPEC committed to improving energy efficiency by 1 per cent per year by the year 2000.
- NRCan recruited more than 200 companies to become Industrial Energy Innovators. These companies represent 70 per cent of energy use in the manufacturing and mining sectors, and now participate as well in the VCR.
- CIPEC published its second Annual Report, documenting energy use in the manufacturing and mining sectors from 1990 to 1994. During this period, Canada's manufacturing and mining sectors increased production and energy use, improved energy efficiency, and reduced CO₂ emissions through a variety of strategies, including energy efficiency and increased use of electricity and biomass.

Canadian Energy Management and Environmental Training Program

Purpose

To provide energy users with opportunities for comprehensive skills development in energy management.

Program Description

The Canadian Energy Management and Environmental Training (CEMET) Program facilitates skills development for the industrial, commercial, government and institutional sectors. CEMET operates through 24 community colleges and CEGEPs, providing needs analysis services, competency-based evaluations, training materials, and course design and delivery.

Achievements in 1995-96

- To help clients plan energy-efficiency programs, CEMET developed model training plans and a training catalogue for the industrial, commercial and institutional sectors.
- To help clients identify energy-efficiency opportunities, CEMET developed auditing workshops for small and medium-sized businesses, and case studies demonstrating the benefits of training in the industrial, commercial and institutional sectors.
- To help clients implement training, CEMET:
 - developed a comprehensive building operator training program through the college network;
 - developed training plans for NRCan's FBI retrofit project in partnership with Seneca College and Rose Technology Group;
 - developed a business plan for workshops to train facilities staff of small and medium-sized businesses;
 - developed a training needs assessment model for the hospital sector;
 - developed a training video and promotional materials; and
 - facilitated the training of about 250 students in energy-management courses and workshops.

Overall, the sectors participating in CIPEC committed to improving energy efficiency by 1 per cent per year by the year 2000.

Industry Energy R & D Program

Purpose

To encourage industry to develop new technologies that decrease energy consumption and environmental impact.

Program Description

The Industry Energy Research and Development (IERD) Program supports the development and use of new energy-efficient processes, products, systems and equipment proposed by industry. The technologies might be applied in any of the industry, transportation and building sectors.

The cost of technology development is shared with industry and other project participants. The average level of IERD's repayable contribution is 35 per cent of total project costs, although funding can increase to a maximum of 50 per cent of eligible costs, depending on technical risk, potential energy savings, and how much the technology could improve Canada's economic competitiveness. Projects are reviewed and recommended by the IERD Advisory Board, which comprises representatives from several federal departments and agencies, including Industry Canada, the National Research Council, Environment Canada and Transport Canada.

Clients of the IERD Program range from innovative small and medium-sized R&D companies striving to carve out market niches to Canadian divisions of multinationals competing for product mandates within their firms. IERD forges links between technology developers and end-users to encourage the widest possible application of technologies. It also promotes the formation of research consortia to accelerate the development and commercialization of technologies. Technology transfer, a major component of the program, ensures broad dissemination of advances in technology

and knowledge, and provides focused monitoring during development.

Achievement in 1995-96

- The Stackpole Powder-Metallurgy Project supported by IERD was completed. The innovative process developed by this project has resulted in the manufacture of high-quality, low-cost automotive parts using 50 per cent less energy and producing 40 per cent less waste than traditional manufacturing techniques.
- In 1994-5, with funding from IERD, Trench Electric completed a successful field trial of a prototype VAR compensator at Monroe Automotive in Owen Sound, Ontario. This unit saves electricity and extends the life of a wide range of electrical equipment in the plant. As a result in part of this successful field trial, Trench Electric established a separate manufacturing facility in Toronto for this new product in 1995-96.
- With IERD funding from 1991-92 to 1995-6, GE Canada advanced the technology of its large hydro turbines and hydro generators to make them more energy-efficient. This helped the company's plants in Lachine, Quebec, and Peterborough, Ontario, to win export orders, particularly in China.

Industrial Targeted Program

Purpose

To identify emerging energy-efficient technologies and development opportunities that will decrease energy use by industry.

Program Description

The Industrial Targeted Program (ITP) identifies technical barriers to increasing the energy efficiency of Canadian industries and supports the development and implementation of technological solutions that contribute to a cleaner environment, improved productivity, better products,

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than traditional

manufacturing

techniques.

reduced waste and a stronger market position for Canadian companies. In particular, the program focuses on energy-efficient technologies that offer the highest rate of return on R&D investment for Canada's industrial sector.

ITP identifies R&D opportunities in specific sectors and conducts technology assessments of these opportunities. This involves describing the technologies, their potential energy benefits, state of development, effect on the environment and market potential, and the barriers to and economics of implementing them. Technology development projects and field trials are subsequently launched in partnership with industry.

Clients include the pulp and paper, iron and steel, cement, oil and gas, and food and beverage sectors. Industry sets the strategic direction, and ITP provides coordination, bringing together interested companies and industrial stakeholders. Activities are developed, managed and funded in cooperation with industry and other partners, including gas and electric utilities, other governments, and equipment manufacturers.

Achievements in 1995-96

- A field trial began at Ontario Northland's rolling-stock repair yard in North Bay, Ontario, to design and implement an intelligent energy-management and control system for a boiler house at a price small and medium-sized operations could afford. Co-founders and stakeholders for this 12-month project are NRCan, Gas Technology Canada and Centra Gas of Ontario.
- CANMET, the British Columbia Science Council, H.A. Simons Ltd., the U.S. Department of Energy, Weyerhaeuser Canada Ltd. and Industry Canada completed a \$2.6 million project to develop mathematical models to simulate and improve the combustion processes of pulp and paper boilers. As a result of this project, Process Simulations Ltd. was formed in Vancouver to market the software and modelling services. The firm

has undertaken contracts with the Canadian, U.S. and European pulp and paper industries.

Heat Management R&D for Industry

Purpose

To help Canadian industry develop, commercialize, acquire or use leading-edge heat management technologies and techniques.

Program Description

CANMET works to develop and disseminate advanced heat-management technologies and knowledge for industrial applications. In addition to improving energy use and environmental performance, these technologies can enhance the economic competitiveness of Canadian industry.

The main delivery mechanism is collaborative, in-house R&D involving manufacturers, service providers and end users in project definition, selection, delivery and financing. CANMET acts as a catalyst in Canadian heat-management R&D for industry. Because of CANMET, technologies are developed and applied in Canada more quickly than would happen otherwise.

The Heat Management R&D Program for industry develops and disseminates advanced heat-pumping, heat-transfer and heat storage technologies and knowledge, including:

- absorption, chemical and hybrid heat-pumping to improve the energy efficiency of industrial processes;
- flow-reversal chemical reactor technologies to recover large amounts of chemical energy from industrial waste streams;
- heat-transfer and storage technologies to recover large amounts of chemical energy from industrial waste streams;
- heat-transfer and storage technologies to recover waste heat and decrease peak-loading in industrial process;
- process integration tools to improve the

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*CANMET acts as a
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energy efficiency of thermal and chemical processes and provide engineering and consulting firms with sophisticated tools to compete in the international marketplace; and

- expert systems and modelling tools to improve energy optimization.

Achievements in 1995-96

- CANMET initiated two projects to develop and demonstrate new, energy-efficient drying technologies. The projects include an energy-efficient method to dry paper and food sludge and to convert such waste into value-added products. The projects are being conducted in collaboration with a pulp and paper company, a food company and a consortium of Canadian gas utilities represented by Gas Technology Canada.
- CANMET began to develop process integration methodologies to reduce liquid effluents and improve energy use in pulp and paper plants. This could decrease fresh water and energy usage by 20 per cent, as well as reduce effluent holdings. This project is being conducted in collaboration with a pulp and paper company and the Quebec government.
- CANMET completed the second year of a five-year project to develop and demonstrate a 50-kW chemical heat pump in collaboration with the food industry, a manufacturer of industrial refrigeration equipment, Canadian gas utilities and a provincial government. This could lead to heating/cooling energy savings using a CFC-free technology and the development of a high-technology manufacturing capability in Canada with good export potential.
- CANMET initiated the development and demonstration of zeotropic refrigeration mixtures for commercial and industrial refrigeration systems that can result in energy savings of 20 per cent. This work is conducted in collaboration with the National Research Council's Thermal Technology Centre, the Cryogenic

Department of the Moscow Power Institute in Russia, a developer of advanced refrigerant mixtures, and end users.

Advanced Technologies for Process Optimization and Control

Purpose

To help industry reduce its energy use and improve the quality of its products.

Program Description

Optimizing energy-intensive processes could reduce primary energy demand in the industrial sector by approximately 15 per cent.

CANMET develops and supports industry's adoption of state-of-the-art control technologies, such as expert systems, artificial intelligence, and advanced computational modelling and related processes. Although process-control technologies offer companies opportunities to save energy, process-design changes are needed to achieve a significant reduction. CANMET leads various consortia of energy users, technology developers, fuel producers, universities and specialized R&D organizations.

Achievements in 1995-96

- CANMET successfully completed a full-scale demonstration of its computational fluid dynamics-based, combustion-simulation technology for coal-fired utility boilers. This project, which was funded by the Canadian Electricity Association, is the last in a series to bring this technology to fruition. This simulation code can provide valuable flame and furnace information to promote clean, efficient use of fossil fuels in all types of combustion devices.
- Using CANMET's computer-based furnace-modelling software program, Gasmac Inc. of Guelph, Ontario, designed and began to market a new gas-fired,

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multi-zone, rapid-heating furnace. The program was used to optimize basic design, set critical dimensions, and measure heat transfer and related parameters. The furnace, which is used for heating ferrous metal rods and billets to forging temperatures, is more energy efficient than conventional induction furnaces because it concentrates the heat on the metal stock.

- CANMET completed a project for the Canadian Carbonization Research Association (CCRA) that shows that, by controlling the catalytic effects of minerals and organic matter in coal, coke reactivity can be improved by 3 per cent. CANMET and CCRA are also pursuing the development and use of supercoke, a high-quality coke that could improve the energy efficiency of iron making by 3 to 6 per cent.
- CANMET developed and used computer models to optimize the blast furnace process and increase its efficiency. These models were used in the evaluation of 65 Canadian coals for Alberta Energy and the Canadian Carbonization Research Association. The model indicates that coal injection, when compared with an all-coke operation, could reduce energy consumption by up to 15 per cent.
- CANMET, through its international consortium on the conversion of Natural Gas, completed an economic evaluation comparing CANMET'S integrated methane to an acetic acid process with conventional routes for acetic acid production. The process avoids the energy-intensive steam-reforming step and offers a more direct route for methane conversion to liquids. The comparison showed that the process being developed by CANMET offers economic advantage in terms of plant pay-out time. The analysis also identified R&D areas for improving the process even further.

Minerals and Metals Technologies

Purpose

To help Canada's minerals and metals industries improve energy efficiency and reduce energy costs.

Program Description

Many of CANMET's research projects in minerals and metals technologies promote the use of recyclable materials, or improve or eliminate industrial processes that use excessive energy. Activities include technology development and pilot-scale demonstration projects with industry that also focus on information dissemination, technology transfer and product commercialization.

For example, CANMET undertakes joint research projects with Canadian foundries and performs energy audits to show where they can save energy and raw materials. A 1 per cent increase in overall yield reduces energy consumption by 1.3 per cent and raw material consumption by 2 per cent. Similar help is available to Canadian mini-mills and steel producers through CANMET's Steel Program.

Other partners include provincial governments and energy utilities, as well as industrial, trade and standards associations.

Achievements in 1995-96

- CANMET contributed technical advice on the conversion of underground mining equipment from pneumatic to hydraulic power. This enables mining operations to reduce their energy consumption by more than 50 per cent. In 1995-96, hydraulic drills were installed for testing in an underground mining operation in Northern Quebec.
- Under CANMET's Mobile Foundry Laboratory Program, technical and energy audits were undertaken at 15 foundries in Alberta, Ontario, Québec and the Atlantic provinces.

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Gas Technologies R&D Program

Purpose

To develop natural gas technologies for the Canadian commercial and industrial sectors that will increase energy efficiency and reduce energy costs.

Program Description

In line with government priorities and priorities identified by its client industries, the Gas Technologies R&D Program emphasizes the development and dissemination of advanced technologies for energy-efficient industrial processes, gas-fired environmental technologies and gas storage technologies.

CANMET's Gas Technologies R&D Program emphasizes the development of advanced technologies for energy-efficient industrial processes, gas-fired environmental technologies and gas storage. Support for technology development and deployment takes a variety of forms, including in-house applied R&D on specific technologies; participation in cost- or task-shared R&D projects with industry, universities, research organizations or other government departments; and provision of laboratory and technical services on a cost-recovery basis.

Program clients generally belong to one of three groups: gas utilities, small or medium-sized gas equipment manufacturers, and large-scale natural gas users. CANMET seeks to establish alliances between these stakeholders, frequently by organizing multiple-partner research consortia to respond to technology gaps and opportunities and to help identify and launch R&D projects.

Achievements in 1995-96

- CANMET completed the second year of a project to develop an energy-efficient fluidized dryer technology. The technology would allow drying of hard-to-fluidize materials such as minerals, plastic flakes and grains. It would replace or be retrofit-

ted to conventional fluidized dryers and generate energy savings of up to 30 per cent. This three-year, \$360 000 project receives half of its financing from a consortium of gas utilities, a Canadian manufacturer and end-users.

- CANMET completed the second year of a project to develop a new, energy-efficient technology for treating heavily contaminated industrial waste waters. Once developed, the technology would offer significant energy and cost savings while helping to alleviate environmental problems. This three-year, \$300 000 project, performed in collaboration with École polytechnique at the Université de Montréal, receives half of its financing from a consortium of gas utilities.

- CANMET initiated the development of a technology to eliminate traces of methane (a potent greenhouse gas) from the ventilation exhaust air of coal mines while economically recovering large amounts of heat. This three-year, \$700 000 project is financed by a mining company, a provincial government and an electrical utility.

Advanced Combustion Technologies Program

Purpose

To develop energy-efficient, environmentally effective technologies in partnership with industry, government, and other national and international research establishments.

Program Description

CANMET's Advanced Combustion Technologies Program plays an integral role in developing and enhancing stationary combustion technologies. The program's primary focus is applied pilot-scale research and field trials.

CANMET is also an important participant in research conducted with other countries, international research institutes and organizations.

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CANMET initiated the development of a technology to eliminate traces of methane (a potent greenhouse gas) from the ventilation exhaust air of coal mines while economically recovering large amounts of heat.

Each year, CANMET participates in more than 40 joint research projects with industry and government clients to help serve the residential, industrial and electrical utility sectors that burn natural gas, oil, coal, biomass and waste.

Achievements in 1995-96

- CANMET, BC Hydro and the Canadian International Development Agency (CIDA) entered into an agreement to transfer CANMET's furnace-modelling technology to China. Under the agreement, XTPRI, a federal research institute in Xian, China, assigned two scientists to CANMET in 1995-96 to help develop XTPRI's capability to apply pilot-scale, energy-efficient research findings to large-scale electrical utility facilities.
- A recognized CANMET combustion scientist was named chair of a cooperative international R&D program that will assess and develop technologies for the capture, storage and use of CO₂ emissions from fossil fuels. This appointment reflects the international scientific community's high regard for Canada's efforts in reducing greenhouse gas emissions. This program is supported by the International Energy Agency and is made up of 15 member nations.
- CANMET formed a government-industry consortium to pursue the development of advanced combustion cycles with the ultimate objective of improving the energy efficiency of power generation while reducing CO₂ emissions. In its Ottawa laboratory, CANMET completed the construction of a new pilot-plant research facility that will be used to develop the technology for the consortium.
- CANMET completed a test program with Nova Scotia Power and ABB to develop two new methods for reactivating fluidized-bed combustion limestone residues for sulphur capture. Improving the efficiency of the sulphur-capture process also increases the overall energy efficiency of the boiler.
- CANMET, along with Nova Scotia Power, Babcock & Wilcox, Tampella Power and several U.S. utilities, completed Phase I of a project to minimize boiler fouling. This problem involves the build-up of deposits in circulating fluidized-bed combustion boilers that burn low-ash waste fuels such as petroleum coke. Phase I provided a better understanding of the causes of fouling. Phase 2 of the program has begun, with a focus on evaluating various approaches to eliminating fouling and improving the energy efficiency and economic attractiveness of burning lower-grade fuels.

Chapter Eight

Energy Efficiency — Transportation

Transportation Energy Use

Energy is used for road, rail, air and water transportation. In 1994, the transportation sector used about 27 per cent of total secondary energy, or 1 950 PJ. In the sector, road transportation accounts for about 81 per cent of energy use (1 579 PJ), with the remaining demand coming, in descending order, from air, water and rail transportation. As shown in Figure 12, gasoline accounts for almost 75 per cent and diesel fuel for 23 per cent of total energy use in the road segment, and alternative fuels, such as propane and compressed natural gas, account for the remaining 2.5 per cent.

Gasoline consumption in the road segment is almost exclusively attributable to light-duty vehicles (LDVs): cars use 67 per cent, light-duty trucks (less than 3 864 kg) use about 29 per cent, and medium and heavy trucks use about 4 per cent (see Figure 13). However, heavy trucks account for most diesel use. LDVs continue to be modest consumers of road diesel.

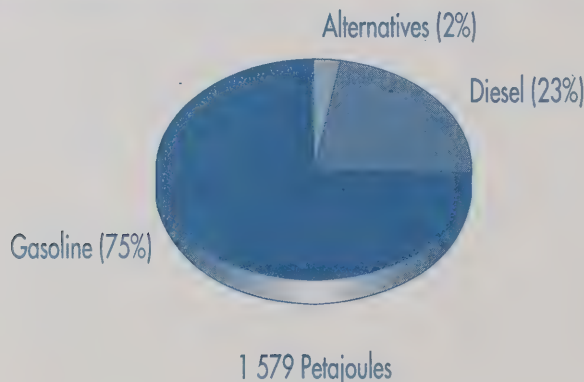
Developments in Energy Efficiency

In 1994, Canada's LDV fleet comprised about 16.2 million vehicles, of which 76 per cent were cars and 24 per cent light trucks. This represents an increase, since 1990, of more than 4 per cent in the total number of vehicles and a shift of 1.7 percentage points from cars toward light trucks. This trend results partly from the decline since 1990 in the proportion of cars in LDV sales from 68.7 per cent to 61.6 per cent.

Although the shift from cars to light trucks in the stock and sales of LDVs suggests a deterioration in the average efficiency of LDVs in Canada, manufacturers have been able to improve the average efficiency of new cars by about 1 per cent per year since 1990. On the other hand, the average efficiency of light-duty trucks in 1994 was essentially unchanged from 1990.

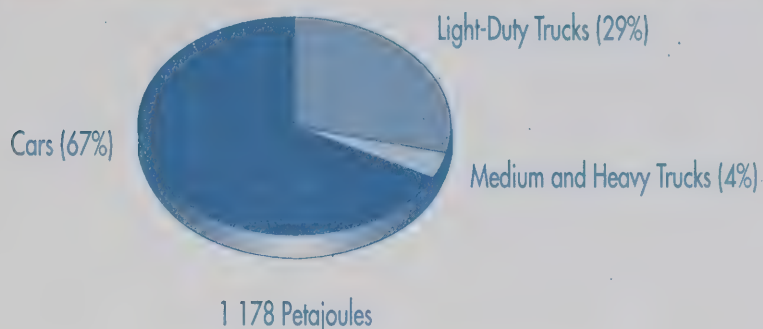
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In 1994, the transportation sector used about 27 per cent of total secondary energy.

Figure 12. Road Segment Energy Demand by Fuel, 1994



Sources: Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, Cat. no. 57-003, 1994-IV.
NRCan, Transportation Energy Demand Model.

Figure 13. Road Segment Motor Gasoline Demand by Vehicle Type, 1994



Sources: Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, Cat. no. 57-003, 1994-IV.
NRCan, Transportation Energy Demand Model.

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Voluntary targets for company average fuel consumption (CAFC) have been in effect in Canada since 1978. On average, motor vehicle manufacturers have met or exceeded the program targets for cars in every model year. According to CAFC ratings, new cars sold in Canada in 1994 averaged 8.3 L/100 km, up from 8.2 L/100 km in 1990, exceeding in both years the target level of 8.6 L/100 km. The light-truck program targets, which took effect for the 1990 model year, have also been met for each model year. The CAFC ratings of new gasoline-powered light trucks sold in Canada in 1994 averaged almost 11.3 L/100 km, compared with the 1990 figure of 11.1 L/100 km, marginally better than the target level of 11.5 L/100 km.

Between 1970 and 1984, fuel efficiency improved each year on average by 2.2 per cent for new small cars, by 3.7 per cent for large cars and by 4.1 per cent for light trucks. Since 1984, the average fuel efficiency of new vehicles has hardly changed, fluctuating around 1984 levels.

Technological fuel-efficiency improvements usually include improvements to the body and drivetrain, as well as engine upgrades. Improvements to the body and drivetrain include:

- transmission changes (increased number of gears, electronic overdrive);
- reduced weight;

- reduced drag (wind resistance);
- better-performing tires that reduce resistance to pavement (e.g., low-profile performance tire, synthetic rubber);
- better lubricants (synthetics that reduce drivetrain friction); and
- better accessories (e.g., electric cooling fans to replace belt-driven fans).

Engine upgrades can improve fuel efficiency and performance through advances like electronic controls, reduced internal friction and better valve controls.

The typical 1970 passenger vehicle weighed 4 000 pounds and had rear-wheel drive, poor aerodynamics, a V8 carburetor engine and a three-speed automatic transmission. However, vehicle characteristics gradually changed (see Table 6). In 1984, passenger vehicles typically weighed about 3 000 pounds, and more than 50 per cent of these vehicles had front-wheel drive and improved aerodynamics. Four- and six-cylinder engines with throttle-body fuel injection and overdrive transmission were also more common. These changes led to a 36 per cent improvement in fuel efficiency between 1970 and 1984.

Today, new cars commonly have four- or six-cylinder engines and multi-point fuel injection. They often use multi-valve technology, weigh about 3 200 pounds, and have better aerodynamics. More than 80 per cent

Table 6. Typical New Car Characteristics for 1970, 1984 and 1994

Feature	1970	1984	1994
Transmission	Automatic	Automatic	Automatic
Number of gears	3	3-4	4
Control	Mechanical	Mechanical	Electronic
Overdrive	None	Some non-electronic; mainly manual transmission	Electronic
Drive	Rear wheel	More than 50% front wheel	Front wheel
Weight	More than 4 000 lbs.	About 3 000 lbs.	About 3 200 lbs.
Drag	More than 40	Below 40	Below 30
Tires	Belted	Radial	Radial
Engine	6-8 cylinders	4-6 cylinders	4-6 cylinders
Fuel control	Carburetor	40% fuel injection; mostly throttle body	Multi-point fuel injection
Valves per cylinder	2 valves	2 valves	2-4 valves
Horsepower	Approx. 135	Approx. 100	Approx. 140
Lab-tested Fuel economy	13.3 L/100 km	8.4 L/100 km	8.3 L/100 km

have front-wheel drive, and 90 per cent of automatic transmissions have four-speed overdrive. Trends toward heavier and more powerful vehicles between 1984 and 1994 offset technological improvements, resulting in only a 2 per cent increase in fuel efficiency over this period.

Motor Vehicle Fuel Efficiency Program

Purpose

To inform purchasers of new cars, light trucks and vans about the fuel efficiency of these vehicles and to encourage motor vehicle manufacturers to undertake further improvements in vehicle fuel efficiency.

Program Description

Under the Motor Vehicle Fuel Consumption Program delivered by NRCan and Transport Canada, motor vehicle manufacturers have met voluntary annual CAFC standards for new automobiles sold in Canada. In addition, the program provides for publication and distribution of the annual *Fuel Consumption Guide* and the fuel-

consumption labels that manufacturers apply to new vehicles.

A recent Memorandum of Understanding (MOU) between NRCan and the motor vehicle manufacturing industry provides manufacturers with an opportunity to expand their voluntary commitments. The MOU embraces a balanced, more comprehensive approach to motor vehicle fuel efficiency aimed at vehicle owners and operators, as well as vehicle technology.

Achievements in 1995-96

- In November 1995, NRCan signed an MOU on Motor Vehicle Fuel Efficiency with the Motor Vehicle Manufacturers' Association. A similar agreement was signed with the Association of International Automobile Manufacturers of Canada in February 1996. Through the Government-Industry Motor Vehicle Energy Committee, NRCan and vehicle manufacturers are developing a work plan that covers three key areas: communicating and promoting vehicle efficiency, vehicle energy data and reporting, and future vehicle technology.

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A recent Memorandum of Understanding between NRCan and the motor vehicle manufacturing industry provides manufacturers with an opportunity to expand their voluntary commitments.

- In March 1996, NRCan and the United States Department of Energy signed an MOU on Road Transportation Energy Efficiency and Alternative Fuels. The MOU provides a framework for cooperation in the development and analysis of policies and programs with respect to road transportation energy efficiency and alternative fuels.

Auto\$mart

Purpose

To encourage motorists to make fuel-efficient decisions in the purchase, operation and maintenance of their vehicles.

Program Description

Auto\$mart helps motorists understand how their automobile purchasing, driving and maintenance habits affect the environment. It offers information on energy efficiency and opportunities for using alternative transportation fuels.

Auto\$mart works with the private sector to develop joint initiatives to promote fuel efficiency. A key feature of the program is energy-efficiency training for new drivers to help them understand and adopt practices to minimize their fuel usage and vehicle emissions. Through Auto\$mart, NRCan produces and promotes the annual *Fuel Consumption Guide* in partnership with Transport Canada. The guide provides fuel consumption ratings for new vehicles. Auto\$mart also undertakes a range of communication activities and offers information materials for distribution to motorists.

Achievements in 1995-96

- NRCan produced and distributed more than 380 000 copies of the 1996 *Fuel Consumption Guide*.
- NRCan distributed more than 150 000 other Auto\$mart publications.
- NRCan co-funded the production of "Your Car Is on Trial," a television special that aired on CTV in September 1995. The show dealt with the environ-

mental effects of vehicle use and what individual Canadians can do to limit them.

Fleet Energy Programs

Purpose

To help public sector and commercial fleets reduce fuel costs and vehicle emissions through energy-efficient decisions in their fleet operations.

Program Description

FleetWise helps federal government fleets work toward three key objectives: cutting costs by increasing energy efficiency; minimizing the environmental effects of the more than 25 000 federal vehicles; and encouraging the use of alternative fuels in the federal fleet. Departments and agencies are called on to develop action plans and track their progress in reducing fuel use and vehicle emissions. Through information materials, workshops and training programs, federal fleet managers are provided with the tools they need to make effective decisions.

The Pro-Trucker initiative provides seminars on fuel-efficient driving to professional drivers. Since the program started, it has reached over 30 000 truck drivers. As a result of industry consultation, changes to the delivery of the initiative were identified. The fleet energy program recognized the need to develop additional products and services to help fleet managers implement energy-efficient practices that reduce fuel costs and the environmental impact of their fleet operations.

Achievements in 1995-96

- FleetWise was launched in October 1995 at a one-day forum sponsored by government and industry that attracted more than 250 representatives of federal departments and agencies, private sector suppliers, and the alternative fuels industry.
- NRCan initiated a demonstration program with several federal government depart-

FleetWise was launched in October 1995 at a one-day forum sponsored by government and industry that attracted more than 250 representatives of federal departments and agencies, private sector suppliers, and the alternative fuels industry.

ments to demonstrate alternative fuel opportunities to fleet managers.

- NRCan developed information materials and tools to help fleet managers make informed alternative transportation choices.
- NRCan completed development of a delivery framework for FleetSmart, a new program to encourage energy efficiency in commercial fleets.
- NRCan expanded the Pro-Trucker energy-efficiency training program for fleet drivers into Ontario.
- In consultation with industry, NRCan developed a new Pro-Trucker program framework that provides for commercial delivery of the program.

Transportation Efficiency R&D Program

Purpose

To support the development and commercialization of vehicle technologies that reduce fuel consumption, pollute less, and improve the competitive position of Canadian vehicle-component manufacturers.

Program Description

The Transportation Efficiency R&D Program supports the development of Canadian technologies that can directly benefit fleet operators and automobile manufacturers. The R&D focuses on high fuel-efficiency, low-emission technologies, such as:

- combustion and exhaust after-treatment;
- advanced energy-storage systems (e.g., flywheels); and
- advanced materials and processes for automotive applications.

Technology development support takes a variety of forms, including direct funding and cost-sharing of innovative projects with industry, especially small to medium-sized technology-based companies. The program links technology innovators with other

transportation stakeholders to promote formation of research consortia. It also provides technical support for development of policies and regulations.

Partners in technology development include component manufacturers, fuel suppliers, industry associations, fleet managers, universities, research institutes, original equipment manufacturers and other levels of government. Other key activities include standards development and technology transfer to promote awareness of technological advances among potential users.

Achievements in 1995-96

- Under its second year of an agreement with Flywheel Energy Systems of Ottawa, CANMET worked to develop electro-mechanical batteries (EMBs), a compact, lightweight energy-storage system. EMBs could be used in cars and buses to significantly reduce fuel consumption and allow zero-emission operation over a limited range. If successful, flywheel energy storage would revolutionize automotive drivetrains. During 1995-96, Flywheel Energy Systems of Ottawa tested 50 composite flywheels. The maximum speed reached was 30 000 revolutions per minute, and the energy stored was 200 Wh.
- Long Manufacturing and CANMET completed research that provided a better understanding of the corrosion resistance of long-life aluminum heat exchangers. Aluminum heat exchangers weigh considerably less than conventional copper ones. With this knowledge, the company will be able to produce lightweight automotive heat exchangers, which will improve fuel efficiency.
- In cooperation with Alcan Karmax, CANMET completed a project that included the development of a large automotive body panel that meets strength, stiffness and dent resistance requirements and weighs 60 per cent less than a comparable steel panel. Tests show that the lighter the automobile, the lower the fuel consumption.

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Chapter Nine

Alternative Energy — Alternative Transportation Fuels

Energy Sources

Alternative energy is generally defined as energy derived from renewable sources such as biomass, small hydro, solar, wind, geothermal, tidal and photovoltaic conversion systems. The term also covers new transportation fuels, such as ethanol and methanol, and new applications of conventional energy sources, such as propane, natural gas and electric batteries to power automobiles.

Alternative transportation fuels (ATFs) currently account for about 2 per cent of Canadian transportation energy use. Propane and natural gas are used directly in vehicles either converted or manufactured for their use. Propane supplies 1.9 per cent of the Canadian road transport market, with about 150 000 propane vehicles in operation supported by about 5 000 public and 2 000 private fuelling stations. About 20 000 natural gas vehicles are in operation, supported by 135 public and 85 private fuelling stations. There are also 135 natural gas-fuelled public transit buses in operation in Canada.

The alcohol transportation fuels, methanol and ethanol, can also be used directly in vehicles. At present, however, ethanol and methanol in the form of ethyl tertiary butyl ether or methyl tertiary butyl ether (ETBE or MTBE) are mainly used to increase the octane and oxygen content of gasoline blends. There are about 500 light-duty methanol vehicles in operation in British Columbia, Alberta and Ontario. Ethanol gasoline blends (up to 10 per cent ethanol) are now marketed in more than 600 stations in the four western provinces, Ontario and Quebec.

Propane

Purpose

To promote propane as a vehicle fuel in Canada.

Program Description

NRCan has several initiatives with Canadian industry to encourage Canadians to buy propane vehicles. Under a first initiative, NRCan works with manufacturers to encourage production and marketing of propane vehicles.

A second initiative is geared to regions of the country that are not well served by ATFs: Quebec and the Atlantic provinces. NRCan, Superior Propane Inc. and provincial governments are conducting market demonstrations of light-duty propane vehicles in Quebec, New Brunswick and Newfoundland. Under a third initiative, NRCan is working with the British Columbia government and the propane industry in British Columbia to demonstrate the environmental performance of factory-built propane vehicles and factory-authorized conversions.

Achievements in 1995-96

- Under an agreement signed by NRCan, the Ontario government, the Canadian propane industry and Chrysler Canada, Chrysler began to produce a full-sized, propane-fuelled van for the 1996 and 1997 model years. The van features a revolutionary liquid-fuel injector system, an advanced propane fuel tank and new emissions-control systems.
- NRCan signed an agreement with the Propane Gas Association of Canada to promote factory-built propane vehicles in

Alternative
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energy use.

British Columbia and assess their environmental performance.

- The regional auto-propane development initiatives in the Atlantic provinces and Quebec expanded the propane refuelling infrastructure, increased the number of new and converted propane vehicles, and resulted in seminars and training programs for mechanics and market demonstrations of propane vehicles.

Natural Gas

Purpose

To promote natural gas as a vehicle fuel in Canada.

Program Description

NRCan offers two programs to develop the Canadian market for vehicles powered by natural gas.

- The Natural Gas Vehicle Program contributes \$500 for each vehicle converted to natural gas, \$1 000 toward the purchase of a new natural gas vehicle carrying a vehicle manufacturer's warranty, and \$500 toward the purchase and installation of a vehicle-refuelling appliance. Natural gas utilities deliver this program on behalf of the federal government.
- The Natural Gas Fuelling Station Program contributes up to \$50 000 for each new public or private natural gas refuelling station.

Achievements in 1995-96

- NRCan began a two-year demonstration project in the lower mainland of British Columbia featuring factory-built natural gas vehicles. By the end of 1997, 300 low-emission, natural gas vehicles will be placed in municipal and commercial fleets. The emission performance of the vehicles will be evaluated, and the results will be used to assess the effectiveness of the vehicles in reducing greenhouse gas emissions and improving urban air quality.

- NRCan provided funding for 1 450 natural gas vehicles, 126 vehicle-refuelling appliances and 10 natural gas public refuelling stations across Canada, excluding British Columbia.
- NRCan and the Municipality of Metropolitan Toronto began a demonstration of factory-modified Ford natural gas pickup trucks. Over the two-year project, 12 natural gas pickup trucks in high-mileage fleet applications will be evaluated. Economic, technical and environmental data will be collected to assess the performance of the vehicles.
- NRCan and the Kamsack and Buffalo Plains School Divisions in Saskatchewan began to demonstrate lower-cost, on-site refuelling for natural gas vehicles. As part of the project, 20 school buses were converted to natural gas and will be refuelled with newly configured hitching-post technology. The purpose of the project is to demonstrate the economic effectiveness of this new approach to on-site refuelling.

Methanol

Purpose

To establish an initial infrastructure of methanol fuelling stations and introduce methanol flexi-fuel vehicles to the marketplace.

Program Description

In vehicles specially adapted by manufacturers, methanol can be combined with gasoline in any proportion up to 85 per cent by volume. These vehicles are known as flexi-fuel or variable-fuel vehicles. The Methanol Light-Duty Vehicle Project was set up by industry and government in 1991. It aims to introduce a significant number of these vehicles into areas served by methanol fuelling stations.

The vehicles have been made available in British Columbia, Alberta and Ontario. The Canadian Oxygenated Fuels Association

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(COFA) coordinates the project and promotes the purchase of methanol vehicles and the construction of methanol fuelling stations.

Achievement in 1995-96

- Based on NRCan funds provided in 1994-95, COFA undertook development work that resulted in the placing of orders for approximately 100 new methanol-fuelled vehicles built by Ford and the completion of several methanol refuelling outlets.

Ethanol

Purpose

To encourage the production and use of ethanol as a transportation fuel and the development of lower-cost ethanol supplies.

Program Description

The Government's initiative to encourage the production and use of fuel ethanol was announced in November 1992. This initiative complemented an incentive in the 1992 federal budget that exempts from the federal excise tax the portion of renewable ethanol in ethanol-gasoline blends. Several federal departments are involved in the ethanol initiative, which is coordinated through the Interdepartmental Steering Committee on Ethanol, chaired by NRCan.

In December 1994, the Government reiterated its support for the production and use of fuel ethanol by announcing the National Biomass Ethanol Program. This program introduced a \$70-million, government-guaranteed line of credit that will make it easier for manufacturers to obtain private sector financing for ethanol plants and provide a means of rescheduling manufacturers' long-term debt in the event of financial difficulties, such as a change in the excise tax status of fuel ethanol. The program is administered by the Farm Credit Corporation on behalf of Agriculture and Agri-Food Canada.

CANMET sponsors projects to improve the conversion of plentiful, inexpensive cellulosic (woody) biomass to ethanol and value-added chemicals. At present, eight active projects are developing key process steps, including pilot-scale projects such as Queen's University's new fermentation process and Tembec Inc.'s wood-fermentation process. These projects are designed to demonstrate technology developed under the program and promote its transfer to the private sector.

Achievement in 1995-96

- CANMET financial support contributed to significant advances in developing technology that will expedite the conversion of biomass feedstocks to fermentable sugars. In addition, there were very promising results in the development of yeast strains that will ferment both the hexose and pentose fractions of these sugars (typically, only the hexose fraction can be extracted). Overall, the technology for the production of ethanol from biomass advanced to the point that an Ottawa company decided to start construction of a commercial-scale demonstration plant in the early summer of 1997.

Alternative Transportation Fuels R&D Program

Purpose

To increase the market penetration of ATFs by supporting technology development and innovative technologies that can be marketed internationally.

Program Description

The Alternative Transportation Fuels R&D Program focuses on developing competitive, energy-efficient, environmentally responsible technologies for:

- gaseous fuels (natural gas and propane);
- alcohol fuels (ethanol and methanol);

Overall, the technology for the production of ethanol from biomass advanced to the point that an Ottawa company decided to start construction of a commercial-scale demonstration plant in the early summer of 1997.

- biodiesel; and
- advanced transportation systems (electric vehicles and batteries, fuel cells and hydrogen).

The program helps Canadian fuel suppliers and vehicle manufacturers develop innovative technologies for sale in domestic and foreign markets.

CANMET provides technical support and shares the cost of activities such as R&D, preparation of technical standards for vehicles and fuelling systems, field trials, and technology transfer within Canada and abroad. Laboratory services in support of cleaner fuels are available at CANMET facilities in Devon, Alberta, and Ottawa, Ontario.

Partnerships and consortia with industry form the backbone of the program. Clients include:

- stakeholders in the Canadian transportation and energy sectors;
- small and medium-sized enterprises concentrating on technology innovation that will allow them to establish market niches; and
- Canadian divisions of North American original equipment manufacturers.

Other partners include industry associations, energy utilities, provincial governments, research organizations, universities and other federal departments.

In addition to technology development, the program promotes ATF technologies to large potential users, such as fleet managers and transit authorities, by working directly with them to address their specific technology needs. Field trials that assess technologies, reveal opportunities for improvement and transfer information are a critical step toward commercializing emerging technologies.

Gaseous Fuels. The automotive industry has introduced propane- and natural-gas-powered vehicles to the market for the 1996-97 model year. Canadian equipment manufacturers and fuel suppliers are vying

to supply this market with advanced, low-cost vehicle components and fuel-supply technologies. CANMET has been able to assemble a diverse group of stakeholders with common goals to form partnerships and R&D consortia to advance technologies to commercialization.

Activities include:

- planning and supporting R&D;
- participating in the development of standards;
- technology transfer; and
- providing technical advice.

Several technologies that could reduce the cost and increase the operating range of natural gas vehicles are under development, including:

- lightweight, low-cost, fuel-storage cylinders;
- natural gas technologies for trucks and buses;
- fuel-injection systems; and
- electronic fuel-management systems.

Activities in the propane area focus on the development of advanced technologies and technical standards.

Alcohol Fuels. Advanced combustion technologies being developed by Thermotech Inc. could produce a new generation of methanol vehicles that meet ultra-low-emission vehicle standards. These technologies would also apply to gasoline- and gaseous-fuelled engines to improve their emissions performance. CANMET is working to establish international consortia to enable industry to improve and commercialize these new engine technologies. CANMET is also helping Canadian manufacturers of methanol fuel-dispensing equipment to improve products being exported to the United States.

Advanced Transportation Systems. Hydrogen, battery and fuel-cell technologies represent the zero-emission vehicles of the future. Considerable progress has been made in the

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CANMET provides technical support and shares the cost of activities such as R&D, preparation of technical standards for vehicles and fuelling systems, field trials, and technology transfer within Canada and abroad.

development of hydrogen technologies and an infrastructure for non-fossil-fuel hydrogen production for transportation applications. Canadian-developed fuel cells are among the most efficient and cost-effective in the world. Advanced technologies for electric vehicles and batteries are developing rapidly. Canada owes its success mostly to the close collaboration in research between industry, universities and governments. CANMET links organizations with similar R&D mandates and participates as a funding partner in various consortia with industry.


Achievements in 1995-96

- In cooperation with the U.S. Department of Energy and the automotive industry, CANMET supports challenges that invite engineering students from across North America to convert production vehicles to run on alternative fuels or to build their own ATF vehicles. The 1995 Hybrid Electric Vehicle (HEV) Challenge at the Chrysler Technical Centre in Auburn Hills, Michigan, was the third in the series of HEV challenges.
- CANMET provided financial and technical assistance to a cooperative venture into pressurizing the Westinghouse

Electric (U.S.A.) tubular solid-oxide fuel-cell technology and verifying the expected thermodynamic voltage gain per unit cell. In close collaboration with Westinghouse, Ontario Hydro designed, built and operated two identical test stations. Results show such great benefits that Westinghouse is rethinking its commercialization strategy and Ontario Hydro acquired a proprietary interest in the technology. Other Canadian funding partners were Gas Technology Canada's consortium of gas utilities and the Canadian Electricity Association.

- CANMET co-sponsored, with industry, the First International Symposium on New Materials for Fuel Cell Systems, which was held in Montréal. The symposium highlighted the requirements for continued materials research for fuel cell technologies. More than 150 delegates from 17 countries participated.
- In March 1996, Ballard Power Systems of British Columbia announced the sale of three full-sized hydrogen fuel-cell buses to the City of Vancouver. The new buses were based on an earlier design that was partly funded by CANMET. CANMET will monitor the three new buses to assess performance.

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Chapter Ten

Alternative Energy — Renewable Energy

Energy Sources

Alternative energy* is generally defined as energy derived from renewable sources such as biomass, small hydro, solar, wind, geothermal, tidal and photovoltaic conversion systems. The term also covers new transportation fuels, such as ethanol from renewable energy sources, and new applications of conventional energy sources, such as propane, natural gas and electric batteries to power automobiles.

The most successful renewable energy source, large-scale hydroelectricity, is well-established and, therefore, not considered alternative energy. All other renewable energy, mainly biomass, supplies about 6 per cent of Canada's total primary energy demand. The pulp and paper industry uses biomass (wood and pulping wastes) for about 50 per cent of its energy requirements, and the residential sector uses wood to meet 6.5 per cent of its energy demand. Some provinces have small hydroelectric installations, totalling 1 528 MW of capacity across Canada. Other renewable forms of energy, however, are little used: wind (23 MW of electrical generation capacity); solar (more than 10 000 domestic hot water systems and 170 commercial and industrial systems); and earth energy. Some renewable energy sources have yet to make a significant contribution to Canada's energy supply. The use of commercial renewable-energy products is expected to increase as technological development, infrastructure investment and behaviour changes expand domestic and international markets.

Renewable Energy Market Assessments Program

Purpose

To assess the potential of renewable energy resources and commercially available technologies for meeting energy and environmental goals.

Program Description

The Renewable Energy Market Assessments Program addresses the potential of various technologies and power sources, including biomass, tidal, small hydro, geothermal, wind and solar energy sources, to contribute to environmental objectives. Activities include:

- compiling data on current demand and use;
- compiling data on supply constraints relative to demand;
- evaluating market prospects for available and new technologies; and
- developing strategies to increase the ability of the renewable energy sector to match products and supply in identified markets.

Achievement in 1995-96

- In September 1995, NRCan held a Green Power Procurement Workshop with representatives from the renewable energy industry and electrical utilities to investigate the feasibility of procuring electricity from renewable energy sources. On

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January 19, 1996, the Minister of Natural Resources announced that "the federal government will enter into discussion with utilities and the renewable energy industry to assess the viability of a federal government 'green' power procurement program." Under such a program, the federal government would purchase an increasing amount of power from energy sources that do not contribute to greenhouse gas emissions. By year-end, NRCan officials had begun discussions with interested parties. These discussions are designed to establish terms and conditions for a competitive process to select pilot projects for procuring electricity from renewable energy sources. The pilot projects will allow the government to assess the viability and cost-effectiveness of a larger-scale procurement program.

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NRCan sponsored the development and production of the first Canadian Renewable Energy Guide by the Solar Energy Society of Canada Inc.

Information and Awareness Program

Purpose

To expand the use of renewable energy technologies through the dissemination of information to consumers and stakeholder groups.

Program Description

Awareness of renewable energy will encourage the use of renewable energy technologies and stimulate industry growth. The Information and Awareness Program examines the information needs of groups, such as the public or the renewable energy industry, and prepares information packages showing how renewable energy technology can be applied economically and reliably to meet some energy needs.

To avoid duplication of effort, NRCan negotiates access to materials and markets information packages through environmental groups, trade associations, provinces and other allies. Information about renewable energy is disseminated through the general consumer information initiative that supports all EAE programs.

Achievements in 1995-96

- NRCan sponsored the development and production of the first *Canadian Renewable Energy Guide* by the Solar Energy Society of Canada Inc. The guide is a comprehensive directory of renewable energy products, services and companies. It also provides interesting case studies on Canadian renewable energy technologies.
- To meet the demand for *Photovoltaic Systems: A Buyer's Guide*, which targets potential buyers of photovoltaic systems, NRCan reprinted the publication. The guide helps consumers determine whether a photovoltaic system may be suitable for specific applications, such as cottages or lodges in remote areas.

Energy from the Forest Program

Purpose

To generate knowledge of and technology for forest biomass production to encourage the use of forest biomass as an energy source.

Program Description

The Energy from the Forest (ENFOR) Program, managed by the Canadian Forest Service (CFS), undertakes R&D on forest biomass for energy through private sector and university contracts, and CFS activities at five research centres. Two primary sources of forest biomass for energy are under study: forest residues, including harvest residues; and energy plantations, involving short-rotation intensive culture of quick-growing trees such as willow and poplar.

ENFOR seeks to enhance technologies for intensive silviculture to improve biomass productivity in conventional forest stands and plantations, and to cultivate the potential benefits of reducing greenhouse gas effects. It also investigates the broad environmental effects of harvesting and using

forest biomass for energy. Economic studies offer regional and national perspectives on short- and long-term advantages and disadvantages, including socio-economic aspects, of different biomass energy sources.

The research involves field experiments and studies, laboratory investigations, data analyses and computer modelling, and socio-economic studies. Results of the research are communicated through scientific papers, technical reports and other publications; workshops and conferences; and demonstrations. By promulgating their results, researchers hope to guide forestry operations toward technology suitable for processing forest biomass for energy, to explain the potential for environmental benefits and impacts, and to offer measures to mitigate negative effects. Key clients include:

- the forest industry;
- provincial forestry agencies;
- federal and provincial energy agencies;
- municipalities;
- private sector entrepreneurs in energy and forestry; and
- private landowners.

Achievements in 1995-96

- CFS continued to develop a model of carbon inputs and outputs in the Canadian forest sector to investigate the impact of Canadian forests and their use, for bioenergy and other purposes, on national carbon budgets and, eventually, on global climate change. Application of the model at a wide range of levels has been promoted. During 1995-96, field studies over a range of ecosystems produced reliable data on storage and dynamics of carbon in soil, the most critical gap in refinement of the model. Collaborative activities at the regional and provincial levels and in the Foothills Model Forest were increased to test the applicability of the national model at the Forest

Management unit level. The model is now being widely used to help clarify the role of bioenergy in global climate change.

- CFS supported operational-scale trials of technology for establishing energy plantations of willow on agricultural land in Ontario and Quebec. During 1995-96, results continued to show that using such plantations as biological filters for sewage sludge confers a double benefit: environmental improvement and considerably increased plantation productivity. Quebec municipalities and Hydro-Quebec support work in this area.
- CFS organized an energy plantation workshop to provide a forum for presentation and discussion of related research results. The workshop proceedings were published to facilitate dissemination of information about fast-growing plantations. The workshop also fostered collaboration between researchers on current and future activities and on strategic directions for the future.
- A major series of long-term regional field experiments on changes in soil properties following intensive biomass harvesting yielded valuable data on environmental effects. CFS began to analyse and assess the data for presentation and discussion at a whole-tree harvesting workshop scheduled for early 1997.
- To facilitate technology transfer from current research activities, CFS publishes the *ENFOR Review*, an annual publication of abstracts from papers and reports on current projects. The 1995-96 *ENFOR Review* contains abstracts from 29 papers on current projects and lists the nine new projects initiated this year.

Renewable Energy Technologies Program

Purpose

To support Canadian industry in developing and commercializing advanced renewable energy technologies.

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Program Description

CANMET's Renewable Energy Technologies Program (RETP) supports Canadian industry's efforts to develop renewable energy technologies, including:

- bioenergy (combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and bio-gas, and biomass preparation and handling);
- small hydro (less than 20 MW);
- active solar;
- photovoltaics; and
- wind energy.

RETP champions and supports technology development and field trials in partnership with the renewable energy industry. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry commercialize its products. Two strategic approaches have been adopted: accelerated penetration of renewable energy technologies into the Canadian market, and exploitation of international opportunities.

Technology development takes several forms, including projects conducted on a cost- or task-shared basis with industry and other partners. Laboratory services in support of photovoltaics and biomass are available at the CANMET facilities in Varennes, Quebec, and in Ottawa, Ontario, respectively. These laboratories have state-of-the-art testing facilities to help clients conduct R&D or technology evaluations. RETP also acts as a catalyst to combine the R&D and funding efforts of other organizations whenever possible, to help industry meet technology-development goals more quickly. It also provides technical support for the development of policies and regulations. In addition to private sector companies, program partners include universities, energy utilities, trade associations, other federal and provincial departments, and research institutes.

RETP conducts technology transfer through field trials, workshops, seminars and participation in trade shows. RETP also participates in the development of technical standards that help remove trade barriers to Canadian technologies in international markets.

Achievements in 1995-96

- CANMET provided Ensyn Technologies Inc. with financial and technical support to scale up its rapid thermal processing technology for converting biomass waste into low-sulphur liquid fuel for electricity generation. There is considerable interest in this technology in Europe, and Ensyn recently sold two pilot units, one to ENEL (Italian Hydro) and the other to the Technical Research Centre of Finland, to demonstrate the technology to European markets. The Technical Research Centre of Finland performed approximately \$500 000 worth of combustion and diesel tests on Ensyn's pyrolysis oil, and the results were promising. As a result of these tests, a \$7.2 million R,D&D project with a Finnish industrial consortium is under way to develop a diesel engine that will burn pyrolysis oil.
- As part of CANMET's PV for the North Program, a 3-kW, grid-connected photovoltaic test system at Nunavut Arctic College in Iqaluit, Baffin Island, was installed to develop photovoltaic technology for larger northern installations such as electric grids. The system was officially opened in July 1995.
- CANMET and Tacke Windpower Inc. (TWP) installed a 600-kW, horizontal wind turbine near Tiverton, Ontario. CANMET provided \$350 000 of the \$1.3 million dollar project. The experimental turbine is designed to withstand the harsh Canadian climate and can generate enough energy to meet the demands of approximately 140 Canadian homes. As a result of this joint project, TWP opened a blade-manufacturing facility in Huron Park, Ontario.

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- The patented perforated Solarwall™ technology developed by Conserval Engineering of Toronto in cooperation with CANMET has been specified for use in a major building-renovation project under way at Bombardier's Canadair manufacturing facilities in Ville St-Laurent, near Montréal. The perforated Solarwall™ cladding will be applied to approximately 10 000 m² of south- and west-facing building walls at a cost of \$2.2 million, making it the largest solar-heating project in the world. CANMET is providing both technical and financial support for the project and will monitor the performance of the system for two years.
- Under a CANMET-supported project, a new battery-insulating compartment had its first field tests with prospective clients. The box increases useful battery capacity by 25 to 35 per cent and increases system reliability in northern climates by up to 20 per cent. Such batteries are an integral part of many renewable energy systems (e.g., photovoltaic).
- CANMET conducted an evaluation that consisted of modelling, testing and optimizing a new photovoltaic snow-removal technology developed in Canada. The technology has been proven and is near commercialization. This technology will reduce system size by up to 25 per cent in snowbelt areas without affecting reliability. A major world manufacturer of modules is backing the technology.
- CANMET supported the development of two low-cost, innovative, mini-hydro turbines that are now licensed, and prototype units have been installed. The prototypes are a 145-kW, tubular "S" turbine (for head up to 30–40 m) developed at Université Laval and licensed to Gestion Conseil S.C.P. Inc. for operation at Rivière-du-Loup, Quebec; and a 700-kW, low-head turbine developed by Barber HyMac Hydro Inc. and installed at Morgan Falls, Nova Scotia.
- As the operating agent for the International Energy Agency Program on the small-hydro task group, CANMET, with the support of Industry Canada, led a Canadian small-hydro industry mission to Poland and supported the establishment of a small-hydro consortium. The consortium will establish two small-hydro projects under a joint venture between Merd Power Construction Ltd. and Canadian Hydro Components Ltd.
- CANMET signed an MOU with the Ministry of Water Resources of China for cooperation with Hangzhou Regional Centre on small-hydro technology.
- With support from CANMET, Conserval Engineering of Toronto completed a project for CIDA to develop a solar crop-drying design for pilot plants in southeast Asia, using perforated Solarwall™ technology. The technology, which was originally developed by CANMET and Conserval, underwent prototype testing and a feasibility study to compare its costs and benefits with those of other technologies suitable for crop-drying applications. These studies showed that the perforated Solarwall™ technology would provide the same amount of crop drying as conventional solar technology at 75 per cent of the cost. To date, two Southeast Asian countries have adopted the Solarwall™ technology for their crop-drying plants, and both installations are reported to be operating successfully.
- The Cetane Enhancer Technology, developed by CANMET for production of high-quality diesel fuel from biomass-derived oil, achieved another milestone. CANMET performed a series of pilot-plant tests under a cost-shared agreement with Arbokem Canada Inc. and BC Chemicals, both of British Columbia. CANMET provided 3 500 L of tall oil-derived cetane enhancer for a field test involving six diesel trucks used by Canada Post Corporation in the Vancouver area. Other


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partners in this field test are Petro-Canada Products, BC Transit, OC Transpo (the regional transportation commission of Ottawa-Carleton) and Environment Canada.

- CANMET provided ABB Canada with support to develop a new fluidized-bed combustor to burn waste wood and pulp sludges. CANMET carried out pilot-scale testing and provided expert advice on the design of a demonstration unit that is undergoing testing at a pulp and paper plant in Ontario.

- In 1995, CANMET entered into a partnership with a wood pellet manufacturer in Rigaud, Quebec, to design and test an advanced wood pellet stove that burns lower-grade wood pellets. Phase testing has demonstrated that the new stove will be more energy efficient and will be able to burn less expensive, lower-grade wood than existing units.



Appendix 1

Ministerial Reports on Actions Under the Federal Buildings Initiative

Introduction

In the fall of 1994, the Minister of Natural Resources launched the Federal Buildings Initiative (FBI) with the President of Treasury Board and the Minister of the Environment. At that time, the Minister of Natural Resources secured the commitment of all federal ministers with custodial responsibilities to:

- participate in the FBI; and
- report annually on their initiatives and successes under the FBI for inclusion in this annual *Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act*.

Below are relevant extracts from the reports federal ministers provided to the Minister of Natural Resources in the spring of 1996. For her part, A. Anne McLellan, the Minister of Natural Resources, made the following statement on the occasion of signing a contract with Rose Technology Group for a \$6.1 million retrofit of NRCan buildings (June 5, 1996).

"One of my major priorities as the Minister of Natural Resources is to make this department the most energy-efficient in the federal government.

"Implementing this FBI project in NRCan buildings and facilities will reduce annual energy bills by at least 18 per cent.

"Energy-efficiency renovations will take place in all NRCan buildings and facilities across the country, from Saanich, British Columbia, to Fredericton, New Brunswick.

The renovations include lighting retrofits, installation of upgraded control systems, improvements to ventilation systems, water fixture replacements, and thermal fluid boilers. At Bells Corners in Ottawa, solar walls are being installed to cut heating costs.

"In addition to energy and cost savings, these upgrades will also deliver significant benefits for the employees here at NRCan, in terms of better lighting, and more comfortable heating and ventilation.

"Improved energy efficiency helps Canada meet its international commitment to the Framework Convention on Climate Change. The FBI is an innovative tool through which the Government of Canada contributes to job creation, economic growth, reduced costs of government and stabilization of greenhouse gas emissions."

Minister of Natural Resources

"Agriculture and Agri-Food Canada has been evaluating the application of the FBI in the department through the project at the Harrow Research Station in Ontario. Further implementation of the FBI will follow as progress is made on the project.

"Department officials will continue to make designs with an emphasis on energy efficiency in all of our new construction, renovation and refits."

Minister of Agriculture and Agri-Food

"The scope of our first FBI project at the Centre for Inland Waters in Burlington, Ontario, was expanded to include the installation of a cogeneration unit which enables the facility to generate its own electricity. This will not only increase energy savings to \$850 000 annually but will also have a significant impact on the reduction of CO₂ emissions.

"We have also embarked on a unique FBI project in collaboration with officials from your department, Public Works and Government Services Canada, and a local landlord. The Place Vincent Massey building in Hull was selected to launch the FBI model in a leased environment, the first project of its kind initiated by the federal government. PVM is a leased building with an option to purchase in 2006. We hope to use this pilot project as an example of how the program can be extended, where appropriate, to leased facilities.

"The positive reaction to the FBI at all levels of government is very promising as it demonstrates that Canadians are taking responsibility for their environment. You can count on our continued support for this innovative program."

Minister of the Environment

"With the recent merger of the Canadian Coast Guard and the former Department of Fisheries and Oceans, our property holdings have expanded greatly.

"The implementation of an energy management strategy is a top priority for the department. Various projects are already underway that will significantly reduce energy consumption, while several more are in the planning stages. Funding this work is always a major consideration and the FBI program may be an appropriate vehicle to deliver some of these projects. Recently, a reminder was sent to all regions to consider the use of the FBI program in planning for capital projects commencing in fiscal year 1997/98."

Minister of Fisheries and Oceans

"Health Canada has and will continue to review opportunities within the department for investing in energy efficiency through the FBI Program. We have recently initiated a major FBI Project in our Health Protection Branch laboratory at 2301 Midland Avenue, Scarborough, Ontario.

"Please be assured that we are continuing to investigate other opportunities for the use of the FBI Program, particularly with respect to the Health Protection Branch laboratories and the Medical Services Branch health care facilities across the country."

Minister of Health

"As part of the review of departmental facilities, which was conducted in 1995, there was no facility identified which was large enough, or had sufficiently high energy usage, to be considered under the FBI program. However, we understand it may be possible to group facilities to take advantage of the program. Accordingly, my staff would be pleased to meet with your officials to discuss this option to determine its feasibility with respect to our departmental facilities across the country."

Minister of Indian Affairs and Northern Development

"DND...is participating along with the other federal custodian departments in the Voluntary Challenge Registry.

"With respect to energy performance contracts, they are underway or are being actively pursued at Trenton and Gagetown, as well as Halifax and Valcartier. A large part of this...can be attributed to the promotional activities of your Federal Buildings Initiative officials.

"In the future, when a base decides to proceed with an energy performance contract, it will initiate that process through a common service organization such as Defence Construction Canada.

"You may be assured of my support, and that of the Department of National Defence, for initiatives aimed at conserving resources."

Minister of National Defence

"PWGSC has developed a strategy which will allow it to push the FBI ahead quickly...If implemented over a period of five years, this strategy will result in an energy reduction of approximately \$12 million a year and in the creation of at least 1200 person years of work in the private sector.

"From the 44 buildings identified as potential FBI projects, PWGSC has signed 7 energy performance contracts, is negotiating 9 other contracts and is involved in different stages of Requests for Proposals for 11 others. The 16 awarded projects will require a private sector investment of \$24 million in energy upgrades which will result in \$3 million in annual energy savings and create 481 jobs in the private sector.

"In the longer term, it is PWGSC's objective to implement energy management projects in all of its inventory over a five-year period in facilities where it is economically and operationally viable. As a next step, PWGSC will call for proposals for the remaining 45 facilities, which are over 10 000 square metres, and then bundle the remaining 268 facilities into several proposal calls.

"PWGSC is also using its capital budget as a means of leveraging the implementation of energy-efficient technology when the simple payback period is in excess of the normal eight years and as a means of financing energy performance contracts.

"PWGSC continues to... promote the FBI."

**Minister of Public Works and
Government Services**

"As you know, the Ministry of the Solicitor General is made up of the Secretariat and four agencies. The agencies are the Royal Canadian Mounted Police (RCMP), the Correctional Service of Canada (CSC), the Canadian Security Intelligence Service (CSIS), and the National Parole Board (NPB).

"With respect to the FBI program, the RCMP has concentrated its efforts on energy-efficiency projects at the Vancouver and the Ottawa headquarters buildings. Detailed energy audits indicated that great savings could be realized with the implementation of energy saving measures. However, circumstances compelled the RCMP to cancel the Ottawa project and to place the Vancouver project on hold. The RCMP's regional office in Halifax, Nova Scotia, is at the preliminary stages of packaging several smaller detachment buildings into an FBI project.

"CSIS took possession of its new National Headquarters building in 1995. The NHQ building was designed and constructed with regard to energy efficiency. New technology was incorporated into the complex to take maximum advantage of energy conservation measures.

"CSC is involved in cogeneration, composting, re-lamping and reduction in water consumption. However, CSC has access to capital funds and has found it unnecessary to employ FBI third-party financing. CSC will, however, continue to consider the FBI where it is applicable.

"The NPB occupies leased accommodations, each of which has implemented some form of energy efficiency. My officials will work with PWGSC to identify opportunities for the FBI in our present and possible future leased accommodations."

Solicitor General of Canada

"There have been significant changes in Transport Canada...downsizing, privatization and the transfer of real properties.

"Given the extensive changes, the FBI Program was applied in only a few instances, but we certainly intend to continue with the program and will continue to promote its benefits when the magnitude of our real property inventories has been clearly established."

Minister of Transport

